SEPTEMBER, 1934

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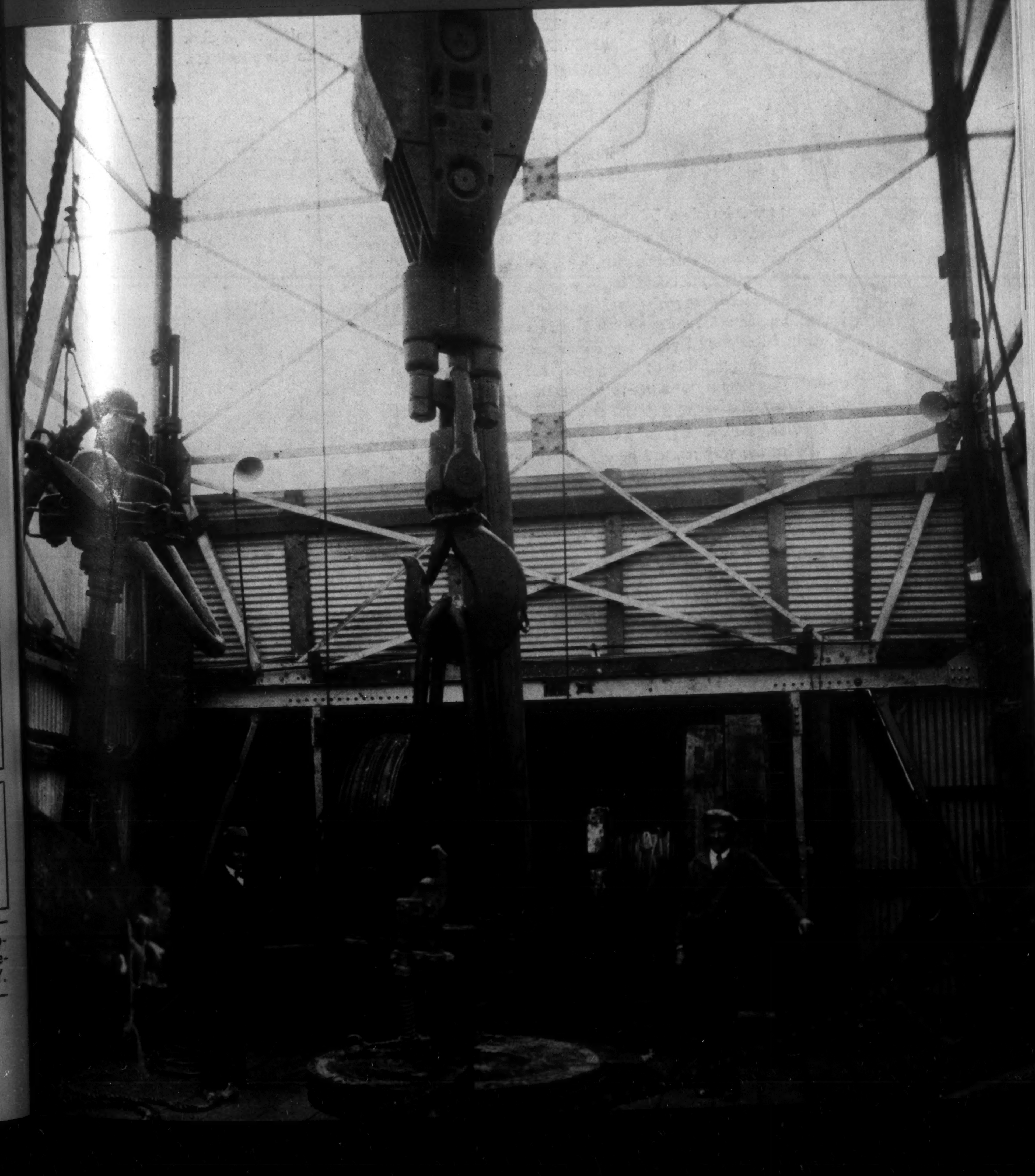
METALS & ALLOYS

The Magazine of Metallurgical Engineering

PRODUCTION • FABRICATION • TREATMENT • APPLICATION

Current Metallurgical Abstracts



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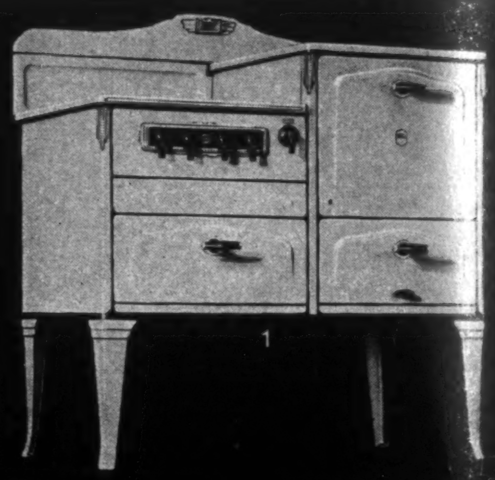
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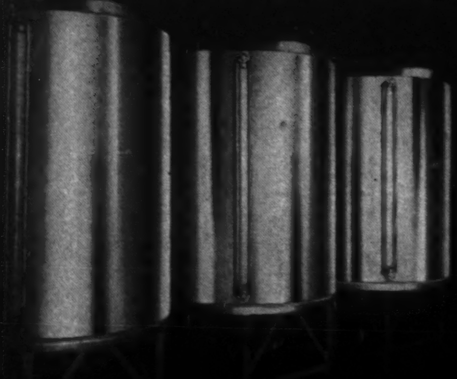
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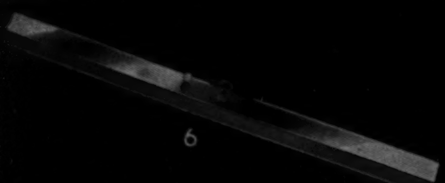
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Production • Fabrication • Treatment • Application

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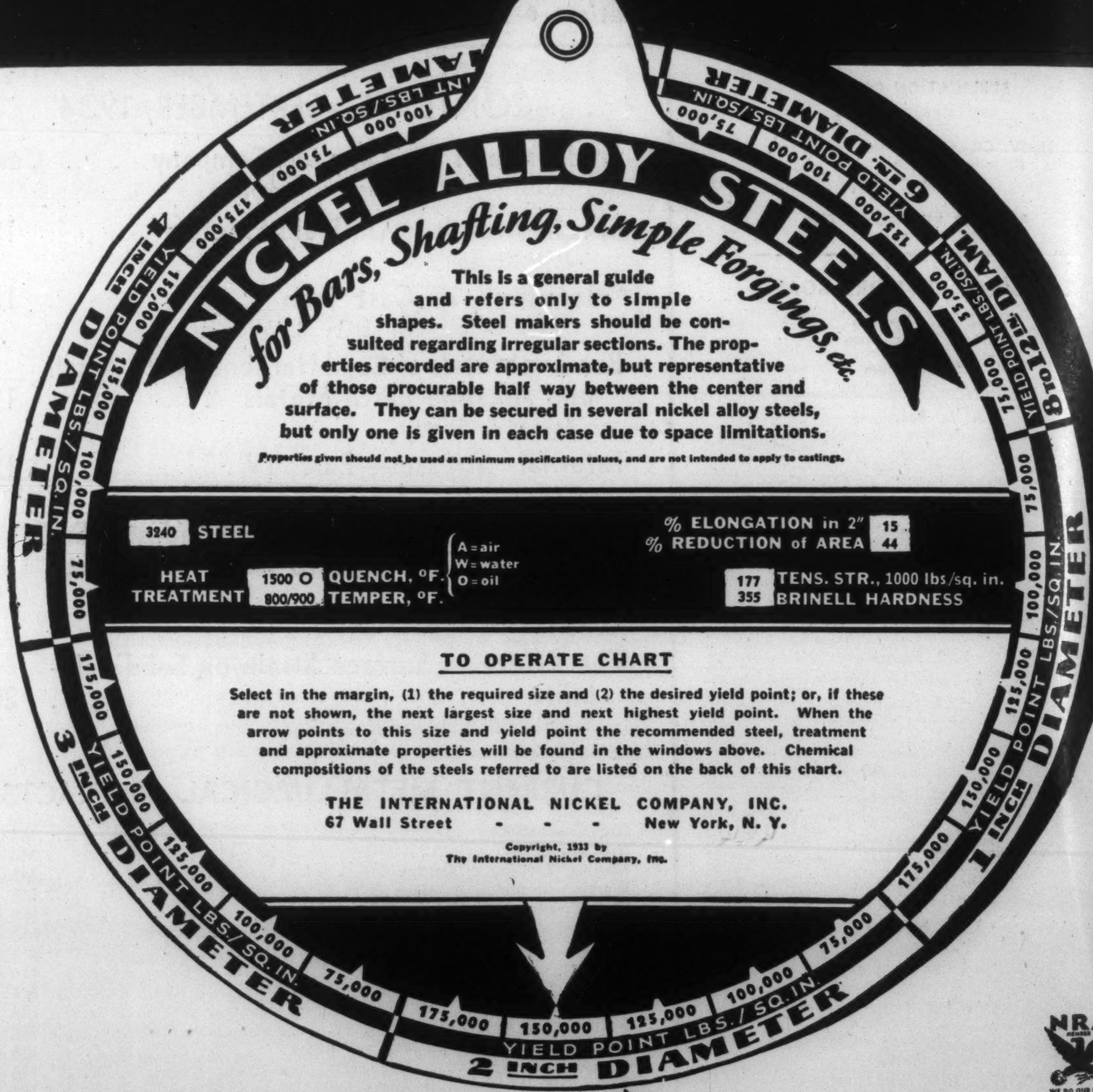
SEND FOR THIS HANDY CHART!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100,000
125,000
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A = air
W = water
O = oil
% ELONGATION in 2" 15
% REDUCTION of AREA 44
177 TENS. STR., 1000 lbs/sq. in.
355 BRINELL HARDNESS

This is a general guide and refers only to simple shapes. Steel makers should be consulted regarding irregular sections. The properties recorded are approximate, but representative of those procurable half way between the center and surface. They can be secured in several nickel alloy steels, but only one is given in each case due to space limitations.

Properties given should not be used as minimum specification values, and are not intended to apply to castings.

TO OPERATE CHART

Select in the margin, (1) the required size and (2) the desired yield point; or, if these are not shown, the next largest size and next highest yield point. When the arrow points to this size and yield point the recommended steel, treatment and approximate properties will be found in the windows above. Chemical compositions of the steels referred to are listed on the back of this chart.

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ENGINEERS, and all those concerned with materials of construction, will find this chart convenient. It indicates at a glance the steel compositions and treatments which will develop a broad range of properties in simple shapes up to 12" in diameter or equivalent sections. Chemical compositions of the steels referred to are listed on the back of the chart. A dependable general guide, saving time and trouble when you want facts quickly. Send for it today. Use the coupon at right.

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HIGHLIGHTS

by H. W. GILLETT

DO YOU want to know what metallurgical engineers are saying, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Action of Fluorspar

According to Meyer and Görissen (page MA 434 L 4) fluorspar additions to the slag improve the desulphurization by increasing the fluidity and basicity of the slag.

Welding

Welding has by far the largest number of abstracts (pages MA 444-449) each month and September is no exception.

Speedy Chemical Analysis

A qualitative and quantitative analysis in a matter of seconds, with apparatus costing no more than a few cents and without the destruction of the sample, is the hope held out by Glazunov's electrographic method (page MA 450 R 1). (CSB)*

What About Bottle-Openers and Corkscrews?

With 5,000,000 can openers using 300 tons of steel annually, the housewife contributes her share to National Recovery. What about our recovery? (page MA 464 R 4)

More on Recovery

This section usually limits its comments to the Current Metallurgical Abstracts in the corresponding issue of *Metals & Alloys*. Therefore pardon the reproduction of a headline from the August 4th issue of the *Daily Metal Trade*—"Code Authority Approved for Wrecking Industry."

We Thought all the Cattle Had Been Bought by the Government

Hain and Gude (page MA 466 L 2) report that in 1933 agriculture and cattle raising consumed 204,736 tons of wire products, and that 1934 should use more than twice as much.

Why Armenia?

Quiring (page MA 466 R 4) evidently went to considerable trouble before he arrived at the conclusion that the production of wrought iron from hematite first took place in Armenia about 1400 B. C.

Minus 253 Degrees Centigrade

De Haas and Hadfield (page MA 460 L 7) extend the study of the effect of temperature on properties of iron and steel down to the temperature of liquid hydrogen.

"We are lost" the captain, etc.

Musser (page MA 461 L 8) reported before the American Petroleum Institute that in a little over 12 years a tanker in gasoline service would lose 30% of the thickness of ½ inch plate.

Corrosion of Metals and Alloys at Elevated Temperatures

Portevin, Pretet and Jolivet (page MA 460 R 2) describe a new method for studying the corrosion of metals and alloys at elevated temperatures. Data show that beryllium exerts a strong anti-scaling effect in a 2% beryllium-iron alloy.

Temper Brittleness

After an exhaustive literature review, Houdremont and Schrader (page MA 437 L 2) conclude that nothing definite can be said at present as to the cause.

Welding Heat Energy

Schroeder (page MA 446 R 5) gives a formula and table for the total required heat energy for welding.

Produce Metals by Thermal Dissociation

von Arkel (page MA 430 R 1) suggests that high melting point metals be produced by the thermal dissociation of their compounds. It is pointed out that some alloys can also be produced by this method.

Treat Brass with Carbon Monoxide

As the presence of cuprous oxide lowers the physical properties of brass, Reitmeister (page MA 432 R 3) suggests the use of carbon monoxide to eliminate this defect.

Sulphur in Cast Iron

The sodium carbonate treatment of cast iron in the ladle is effective when heavy castings are dealt with, but has not been found satisfactory with small batches of metal as the time necessary for the thickening and removal of the soda slag is sufficiently long to cause the temperature to be too low for pouring. Colbeck and Evans (page MA 433 L 1) mention the use of sodium carbonate in fused blocks added to the ladle with the rest of the charge.

Heredity Effects in Cast Iron

Keil, Mitsche, Legat and Trenkler (page MA 433 L 9) discuss this subject in the *Archiv für das Eisenhüttenwesen.* A correlated abstract on this subject appears on editorial page 184.

Sulphur in the Gas

Maurer and Bischoff (page MA 434 L 4 and 5) have determined the extent to which the sulphur in the waste gases in the open hearth affects the slag and metal. They decide that SO_2 is the bad actor. (CHH)*

Duplexing

Portevin (page MA 434 R 5) reports that excellent steel results from bessemerizing followed by a deoxidation by the emulsion process, which involves emulsification of the slag and metal by impact. (CHH)*

Ingots

Nelson (page MA 434 R 7) tells all about the solidification of all shapes of steel ingots, and shows how to calculate the amount that has solidified at any time. Northcott (page MA 434 R 9) blames dendritic segregation on phosphorus and shows how segregation of all sorts of things occur in a twenty ton ingot. (CHH)*

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* The initials are those of the section editor.

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EDITORIAL COMMENT

Old Line Materials

WE ARE told that if something new and useful is devised, people will buy it if it is properly called to their attention. Such new developments naturally arouse a good deal of interest, they are news in the daily papers as well as in the technical journals, and are in demand as subjects of talks before the local sections of our technical societies. The attention paid to such things may lead the casual observer to overestimate their importance in the general scheme of things metallurgical.

The old line materials whose utility has been proven by years of successful application may be more commonplace, but they are no less important and they have their pressing problems, even though these are of the detailed, plodding type rather than the spectacular kind. There is one organization, the American Society for Testing Materials, that deals with the metallurgy of the venerable old products as well as of the vigorous young ones. It takes a long view of things and has a stability and a deliberateness of action which, while sometimes irritating to those who want results tomorrow whether they are wholly right or not, is very suitable for the type of problems with which it has to deal.

Its slow, deliberate, but thorough ways of doing things have brought results. No other methods than those of the A.S.T.M.'s extensive long-time tests could have so decisively brought out the value of copper-bearing steels for atmospheric exposure. At the June meeting there were reported results of corrosion tests on materials exposed 17 years ago, which are still being inspected and reported upon. The personnel of a committee which is making such studies changes a lot in such a period, and it takes an organization with a long view and a lot of stability of purpose to keep going without getting side tracked.

In some of the committees that deal with such problems there is a tendency toward letting the results that are obtained and recorded speak for themselves, but on the whole there is a strong tendency to do something with the data and make engineering recommendations for changes in specifications and in practice just as soon as a reliable basis for a decision has been secured.

One of the outstanding features of the meeting was the raising of the question whether the decrease in corrosion rate of buried pipes after 4 or 5 years is not ascribable to the more uniform packing of the soil rather than to protective action of accumulated corrosion products and whether the initial corrosion could not be as effectively retarded by coatings that would tend to produce uniform distribution of air and moisture about the pipe as by those that attempt to keep air and moisture entirely out of contact with the metal, that is, to make the coating act from the start the way a well-packed soil acts after several years. The economic results of such a conclusion would be huge in view of the amount spent in replacement of pipe or in its protection against the action of corrosive soils. That the soil, rather than the type of ferrous material in the pipe, is the major variable has been evident from the results of the soil corrosion work from the beginning, and is continually emphasized by the data as they accrue from year to year.

This particular long time study on old-line materials has been carried on by the National Bureau of Standards rather than by the A.S.T.M., but the interest of the A.S.T.M. in all such long-term projects was evidenced when the session at which the soil corrosion work was reported voted to ask the Executive Committee to include special mention of the project in its communication to the administration at Washington protesting against the crippling of the Bureau.

That communication will doubtless be most diplomatically worded, but no one in attendance could fail to feel the undercurrent of disgust running through the meeting at the skimping of the "ordinary" budget with the resultant squeezing-out of constructive projects like this, while with the other hand shovelling out funds most prodigally for so many crazy, temporary schemes, with one eye on emergency employment and the other on the building up of a political machine outside the civil service.

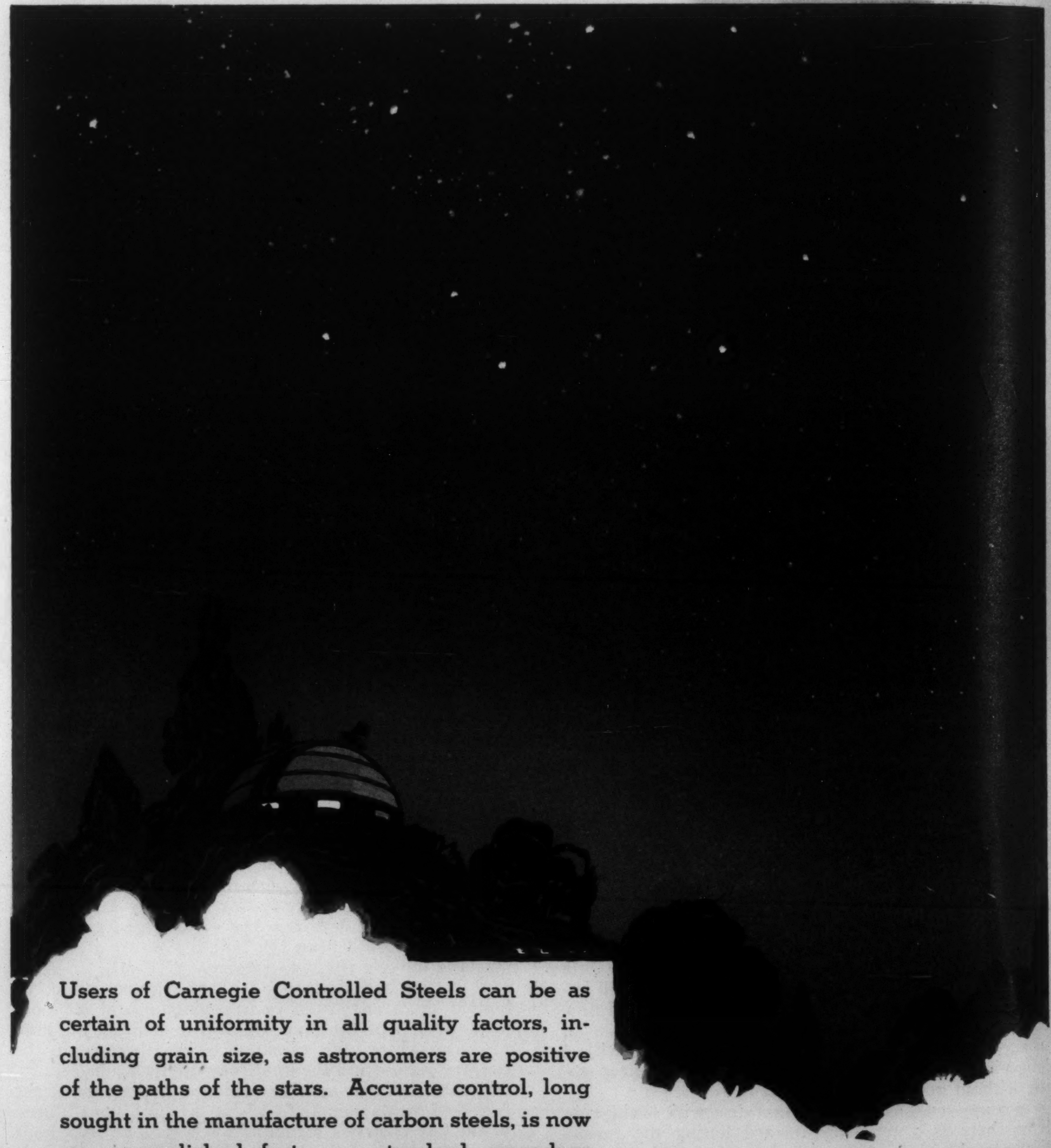
It is too bad that such an atmosphere cannot be bottled up, transported to Washington and let loose in the offices of the New Dealers to indicate the kind of bureaucracy the thinking technical men of the country want—and the kind they do not want.

This action was another evidence of the urge of the A.S.T.M. to do something about the conditions it sees. While the society's communication will go into some Washington waste-basket, the society members can do something with votes.

Old-line materials that came in for attention by reports on work that had been long in progress were wrought iron, ordinary steel in respect to phosphorus and sulphur content, ferrous and non-ferrous materials for combatting corrosion, and the properties of structural steel.

Of less venerable, but well established materials, die castings had their usual attention in the campaign the A.S.T.M. committee is carrying on to bring them to greater reliability and acceptance, and the service characteristics of the light metals and their alloys were reported on. The latter is another step in the co-

(Continued on page 195)



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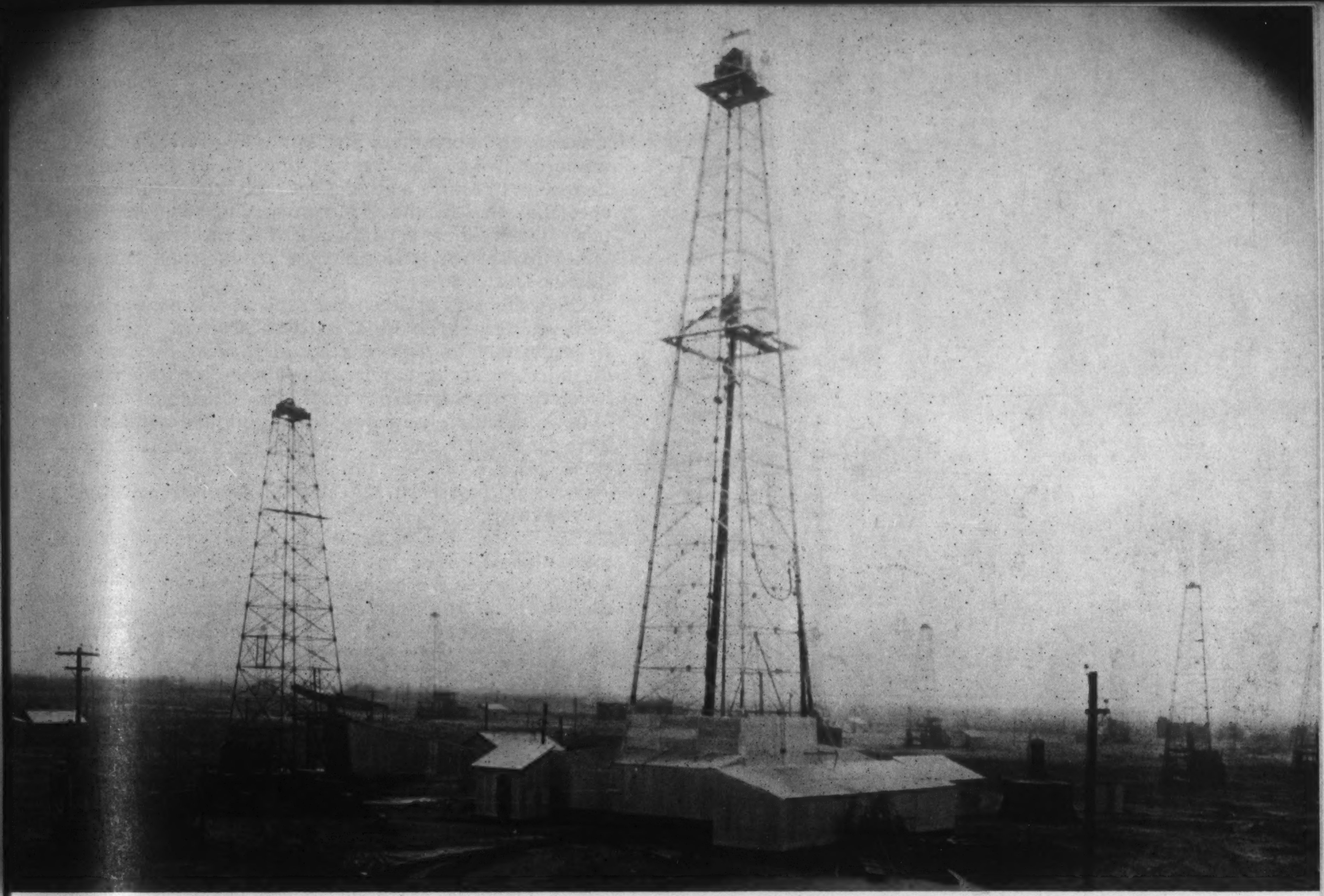

Twin Motor Cable Tool Drilling Equipment of Big Lake Oil Company. (Courtesy Westinghouse Electric & Manufacturing Company.)

Special Metals in Oil Field Practice

P. H. BRACE*

MANY INDUSTRIES whose product is non-metallic, and which, in the public mind, are not at all connected with metallurgy, are, nevertheless highly dependent upon metallurgical materials. Their progress may be, to a peculiar degree, connected with the progress of metallurgy.

When the motorist drives into the filling station for "ten gallons and check the oil," he seldom realizes how much metals have had to do with the production of the gasoline and oil he uses. He probably knows that they are distilled in some way and, unless he is fresh from a laboratory course in chemistry, he probably thinks of a commercial still as made of metal rather than of glass, so he would not be surprised to learn that very serious problems of the oil refiner are connected with metallic equipment for cracking at high temperatures.

But he would be likely to be surprised at the role metals have played in the production of crude oil before it gets to the refiner.

In the locating of a new oil field, geophysical prospecting today takes much of the wildness out of "wildcatting." Before the geophysical prospector can proceed to his magnetometric surveys, he must have extremely accurate measurements of the intensity and direction of the earth's field. Certain specially prepared iron-nickel alloys, such as Hipernik and Permalloy, are so extremely susceptible to weak magnetizing forces that they form a very efficient "pick-up" for the weak magnetic field of the earth. Two such bars, end to end with a small air gap between, set across the earth's field instead of parallel to it as in the ordinary compass, form an ultra-sensitive compass or magnetometer, suitable for this use.

When the ordinary compass comes into play, we find that cobalt, chromium, tungsten steel permanent magnets of recent development and superior quality help to perfect this tool of the scientific explorer. The old-time surveyor's steel tape used to change some ¾ inch in its 100 ft. length between a crisp winter and a hot summer day, but the modern Invar tape changes less than a tenth of this amount, and is corrosion-resistant to boot.

When a promising location has been found, the well has then to be drilled, in some cases going down 10,000 ft., through whatever formation nature happened to interpose, and the formations can be mighty tough ones that wear out the drilling tools with disconcerting rapidity. Here tungsten, tantalum and similar carbide inserts and welded-on facings of chromium-cobalt-molydenum alloys put teeth on the tools that enable them to bite their way on down without such frequent replacements.

The power for drilling, and later for pumps and compressors will in a new field probably first be provided by Diesel or gas engines, and the crude oil or

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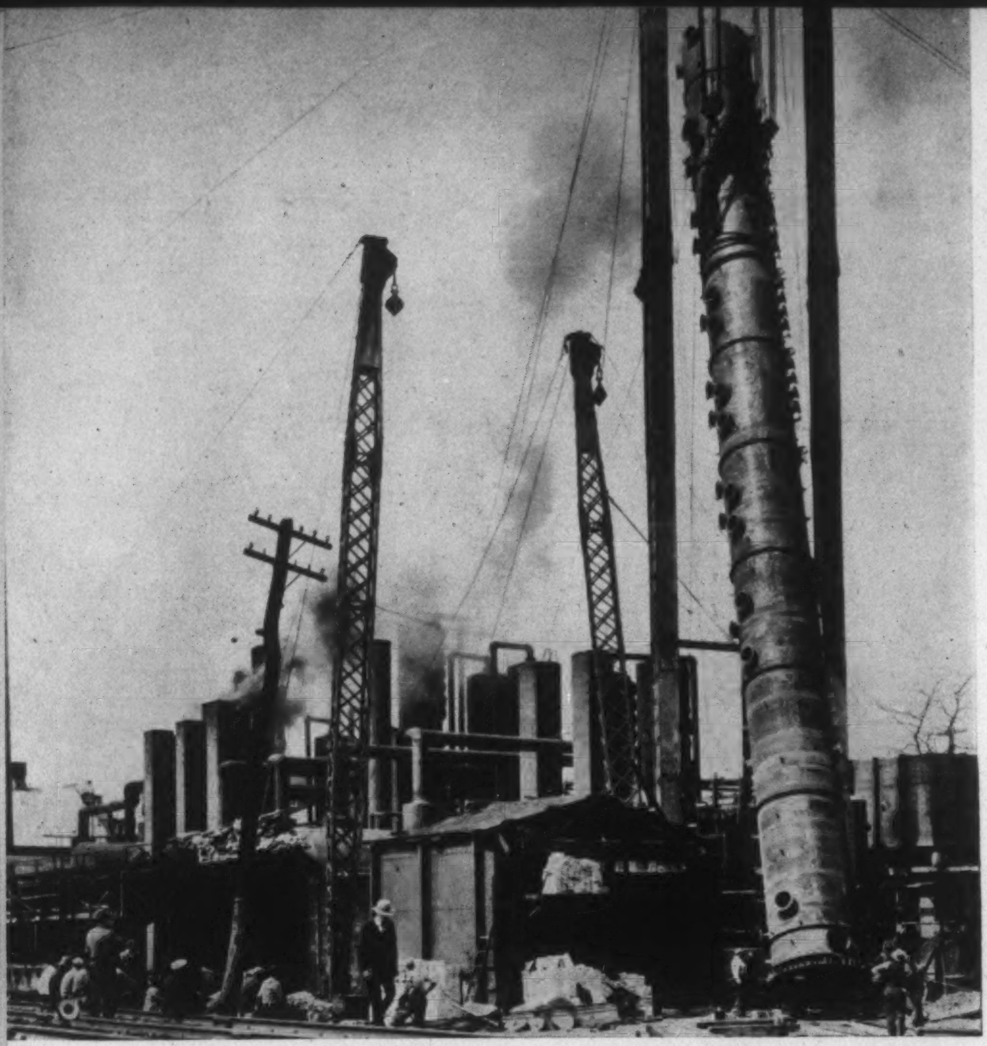
* Research Laboratory, Westinghouse Electric & Manufacturing Company.



One of the tallest fractionating towers ever built was recently completed for the United Refining Company, Warren, Pennsylvania. This tower is six feet nine inches in diameter and 110 feet high. It was constructed entirely by arc welding and shipped in one piece weighing 80 tons. The tower was welded by The Struthers-Wells Company, using the shielded arc process with equipment manufactured by The Lincoln Electric Company.

unpurified gas may be high in hydrogen sulphide, bringing in corrosion troubles that are sometimes so difficult to combat that steam plants and electric power must be promptly put in.

The drill stem in rotary drilling or the cable in cable tool drilling must stand very rough treatment, and when it passes through hydrogen sulphide areas, is liable to embrittlement from its action. Since this embrittlement is not permanent, the cable, for instance, can be "rested" from time to time to let it recover, but resting anything in drilling an oil well is not pleasing to the operators. Galvanized cables are quite resistant, so zinc adds itself to our list of useful metals for oil field use.

As the well is drilled, the casing must go down and the casing string in a deep well has to be strong, to support its own weight, but so much of it is used that it cannot be a very expensive steel either in material or fabrication cost. It would be helpful if it could be corrosion-resistant, for it may encounter saline water, but really corrosion-resistant steels are not yet available that are cheap enough for casing, so metallurgical measures are not yet seriously applied, but in the worst cases, neutralizing or inhibiting chemicals may be used.

The steels for upper part of the casing string for deep wells will probably hereafter be chosen from the low alloy, inexpensive, high strength steels alloyed with two or three of the elements chromium, manganese, silicon, copper, vanadium, molybdenum, since such steels have high yield points and are quite easily fabricated.

Casings and tubing have offered a fruitful field for the efforts of the production metallurgist. Seamless tubes are made by a variety of ingenious methods that allow rapid production, while the welding of flat stock into pipe form by an even greater variety of methods has made almost unbelievable advances in speed of welding and soundness and strength of weld. Automatic control of the welding process, by devices that themselves require suitable, specially chosen metals in special parts of the equipment, such as electrodes, takes the welding art into a highly mechanized field, which makes for uniformity of product and low production cost.

Once the well is down the sand at the bottom must be kept out and the oil let in, by a strainer. It is next to impossible to replace a strainer, so if the strainer mesh corrodes to too large openings, or conversely, becomes clogged with corrosion products, production is impeded or entirely stopped. While many materials have been tried and tin bronzes serve in many locations, pure nickel is preferred by many operators. Price is no particular object for a strainer in a badly corrosive well.

The tubing through which the oil is pumped or raised by an air or gas lift is the next problem, one quite similar to the casing problem, and depending on the particular corrosive conditions obtaining, ordinary steel, high copper-bearing seamless, or heavily galvanized wrought iron tubing may be preferred.

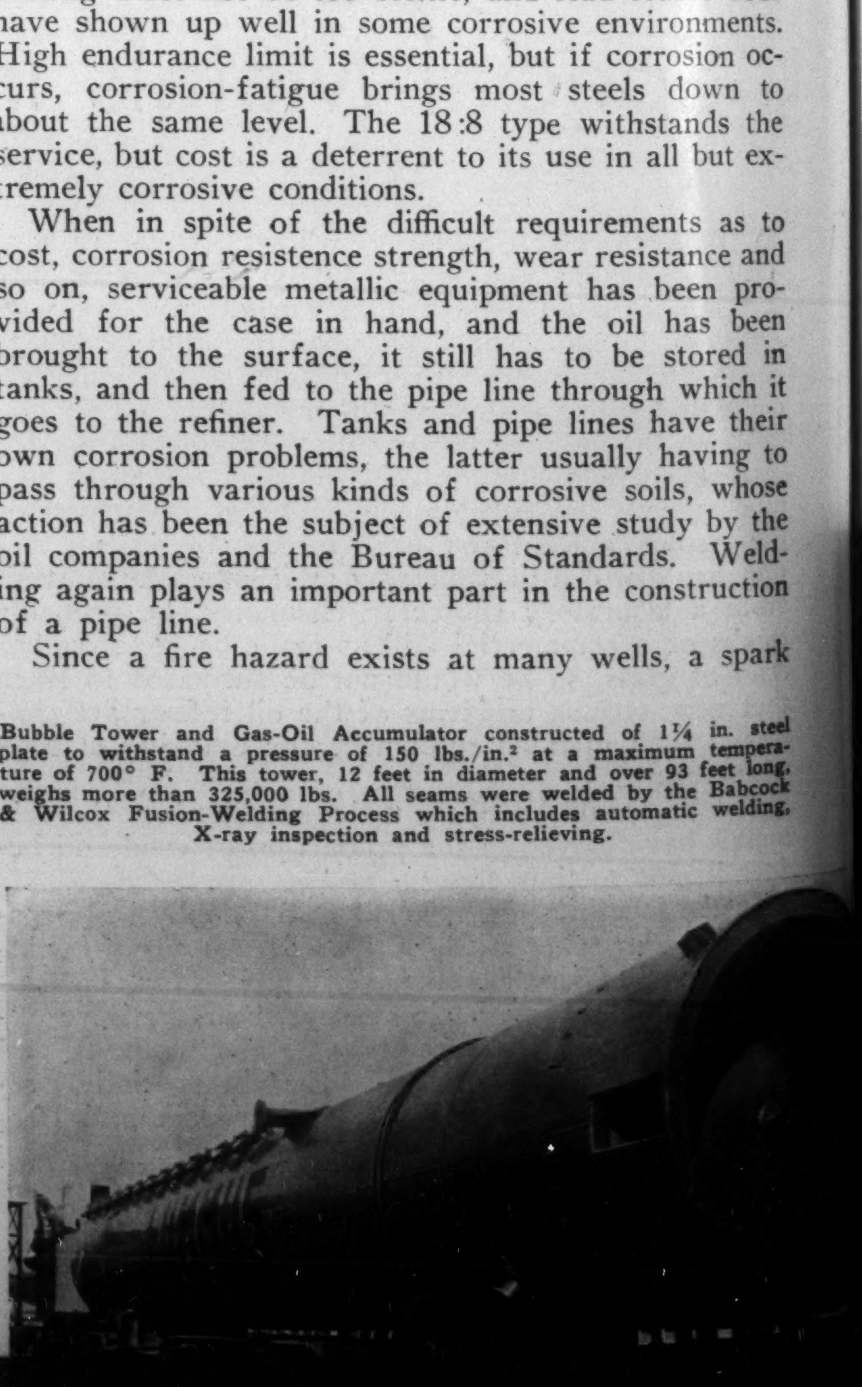
The oil is usually raised through the tube by a barrell-type of pump, with a complicated set of valves and valve seats which must resist both wear and corrosion. Many different alloys, such as high chromium, high nickel steels, aluminum bronze, nitrided steels, are being used or tried. When the chromium nickel alloys are welded in construction, titanium, tantalum, or columbium may be added to preserve corrosion resistance in the material of, and adjacent to, the weld.

The pump is operated by the sucker-rod, which again must stand severe service. The elastic deformation of a long sucker-rod is so great that a protective coating must not be too brittle, and lead-coated rods have shown up well in some corrosive environments. High endurance limit is essential, but if corrosion occurs, corrosion-fatigue brings most steels down to about the same level. The 18:8 type withstands the service, but cost is a deterrent to its use in all but extremely corrosive conditions.

When in spite of the difficult requirements as to cost, corrosion resistence strength, wear resistance and so on, serviceable metallic equipment has been provided for the case in hand, and the oil has been brought to the surface, it still has to be stored in tanks, and then fed to the pipe line through which it goes to the refiner. Tanks and pipe lines have their own corrosion problems, the latter usually having to pass through various kinds of corrosive soils, whose action has been the subject of extensive study by the oil companies and the Bureau of Standards. Welding again plays an important part in the construction of a pipe line.

Since a fire hazard exists at many wells, a spark

Bubble Tower and Gas-Oil Accumulator constructed of 1¼ in. steel plate to withstand a pressure of 150 lbs./in.^{2} at a maximum temperature of 700° F. This tower, 12 feet in diameter and over 93 feet long, weighs more than 325,000 lbs. All seams were welded by the Babcock & Wilcox Fusion-Welding Process which includes automatic welding, X-ray inspection and stress-relieving.



is to be avoided, so the hammers, wrenches, etc., used around the oil field may be made of copper, strengthened by beryllium or titanium, by utilization of precipitation-hardening phenomena, and the steel parts may also be cushioned against sparking by a cushion of a heavy cadmium plate.

Thus before crude oil reaches the refiner, it may have involved the use of iron, nickel, cobalt, chromium, tungsten, tantalum, molybdenum, zinc, copper, tin, lead, aluminum, manganese, silicon, vanadium, nitrogen as nitrided coating, titanium, columbium, beryllium and cadmium. The production of the various alloys in their final form has involved problems in steel making and preparation of special alloys, of casting and rolling, of welding, of threading and machining and so on through the list. Choosing the right alloy for each particular part involves highly specialized problems in corrosion, especially in corrosion fatigue.

So while the petroleum industry is, by definition, a "non-metallic industry," without modern metallurgical progress in devising special alloys to fit special needs the oil fields would be producing oil only at a much higher cost, and our "ten gallons of gas and a quart of oil" would take more money from the motorist's pocket.

The oil industry apparently recognizes that it has metallurgical problems, and actively seeks to solve them, utilizing new alloys as they are produced and shown to be suitable, and encouraging the metallurgist to provide still better ones. There are other "non-metallic industries," however, that have ample room for metallurgical improvement in equipment as vital for them as is some of its equipment to the oil field, but in which the managements are less on their toes in applying metallurgical advances already made, or seeking to have such advances made to order to fit their particular needs.

Metallurgical Needs of Non-Metallic Industries

THE special metallurgical needs of so-called "non-metallic industries," for which their managements know of no really suitable material and so put up with frequent and costly replacements or for which they pay a high price when a cheaper material would serve as well or better, might oft times be filled by some material known to the metallurgist and which he would suggest for trial if only he knew that the need exists.

As Mr. Brace points out, oil producers are not backward about calling on the metallurgical engineer for help, and the metallurgist appreciates the oil industry as a large potential customer for anything that will help him, so they get together readily.

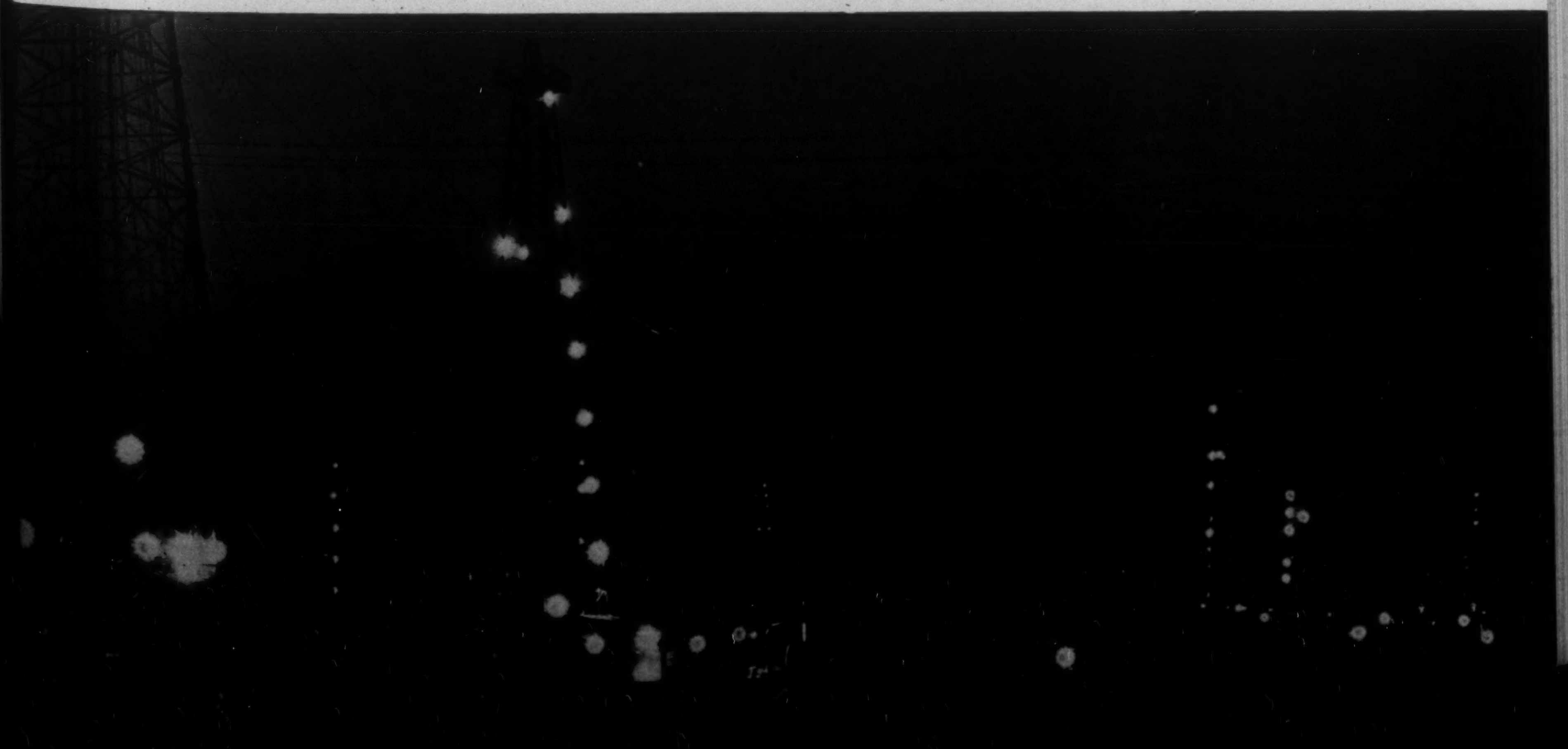
Similar coöperation could be brought about in the other industries, hinted at in Mr. Brace's last paragraph, by public statements of the needs so that they would come to the attention of the metallurgist. Few plants in these "non-metallic" industries may have highly expert metallurgists, but they usually do have chemists, engineers, or some kind of technical man who appreciates the needs even though a better solution than the present one may seem to him to be pretty hopeless. He may be glancing over the articles and abstracts in Metals & Alloys, not from any direct interest in metallurgy as such, but in the hope that he will light upon some suggestion for a way out of his own metallurgical difficulties.

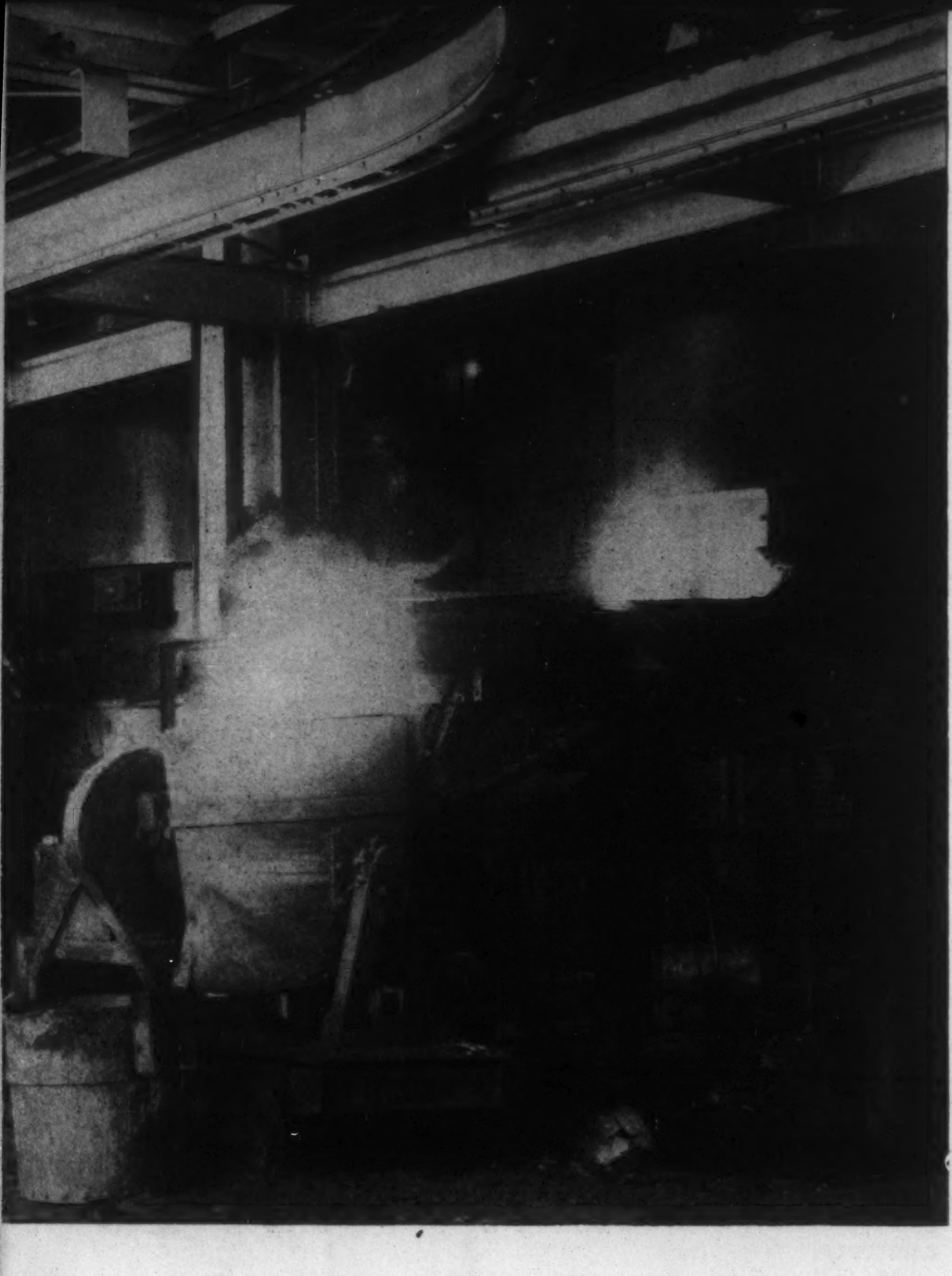
If such a technician will jot down an account of the metallurgical tribulations and "bottle-necks" of his industry, and send to us, we will be glad to publish it, to set metallurgists to thinking up answers.

Metallurgical research workers, seeking something for a particular purpose, may very possibly, pass over, as deserving no further attention, some alloy that doesn't meet their own needs, while if they knew the other man's needs and looked at their "failures" from his point of view, they might find that they had already solved the other chap's problem or were at least on the road toward a solution.

Let the "non-metallurgical" industries tell the metallurgist what they want. He has filled many needs and can fill others, but he must have his attention called to the unfilled ones before he can be expected to function.—H. W. Gillett.

Westinghouse Lighting Equipment on Drilling Rigs in Seminole Area





Cupola Installation at the Peoria Plant of the Caterpillar Tractor Company (Courtesy, Whiting Corporation)

"HEREDITY" IN CAST IRON

By

H. W. Gillett

A CORRELATED ABSTRACT

THE OBVIOUS variables controlling the structure, and hence the properties, of cast iron are composition, particularly as to carbon and silicon, and rate of cooling, especially through the temperature range for separation of primary graphite.

However, even though all these conditions are thought to be equal, irons from different sources or melted under different conditions, may act differently.

There may be a tendency for the structure and properties of the pig iron to repeat themselves in the casting, even though the rate of cooling of the casting be very different from that of the pig.

So many cases of this sort have been recorded that the term "heredity" is often applied to this situation.

For example, Piwowarsky[1] reports greater strength in sand castings when using chilled pig than using the same iron as sand-cast pig.

Allen[2] reports that pieces from the same mine car wheel were remelted in a high-frequency furnace and poured into test bars under identical conditions. The remelt of the chilled tread was white, that from the gray hub was gray, and mixtures of the two were mottled.

Some foundrymen believe that when such observations are made, they refer to a difference in composition, even though the charges were from the same object and are loath to accept the findings in the absence of analytical evidence that all the charges had the same composition.

It is sometimes found, in other types of furnaces, that the reverse is true, and that a white iron melted without change in composition and cooled at a rate that should produce white iron from such a composition, may freeze as a mottled iron, while the addition of a very small percentage of steel scrap to the charge, insufficient to alter its composition or expected behavior appreciably, will make it freeze white.

Wagner[3] claimed that repeated remelting vastly improved the properties, even when no change in composition occurred.

Boegehold[4] found that the dilation-temperature curves for castings from different pig irons showed marked similarity to those of the pig iron from which they were made and considers this "quite conclusive evidence that pig iron quality persists through the cupola melting operation and shapes the properties of the cast iron."

Judson[5] melts a steel rail charge in one cupola, to produce hard iron, melts a soft iron in another cupola and mixes the charges in the ladle and finds the resulting castings to be much stronger, of much lower shrinkage, to require less heavy risers, and to be less affected by changes in casting section than the same raw materials melted in one cupola to produce iron of the same analysis as that of the mixture.

Perhaps the most outstanding case of heredity is in the behavior of coke iron and charcoal iron of the same chemical analysis. That the primary graphite of charcoal iron tends to be more finely divided and nodular, while that of the coke iron tends to separate in long, thick flakes, has long been known, and has been clearly shown by Jominy.[6]

Similar experiences, with two pig irons of closely similar analysis have been reported,[7] among others, by Buffet and Thyssen, Schuz and Stotz.

Hurst[8] concludes that there is a heredity phenomena, with behavior not accounted for by chemical composition, as does Levi.[9]

Portevin,[10] indeed, thought it necessary to voice a warning that the heredity idea could be overdone and invoked to cover up the presence of controllable variables.

With so much evidence that heredity plays a part, theories as to its cause have not been lacking. Johnson[11] ascribed the differences to the presence of oxygen.

Eckman and Jordan[12] made total oxygen analyses by the vacuum fusion method of the irons whose physical properties had been studied by Jominy[6] and found nil to 0.010% in the charcoal and nil to 0.014% in the coke irons, very much lower values than had been found by Oberhoffer and co-workers[13] by other analytical methods, and failed to find the relationship between total oxygen and properties that had been claimed by Oberhoffer.

Cournot and co-workers[14] claim that analytical methods have been perfected that should make possible a better examination of the problem, but, as Thompson[15] points out, any oxygen determination that does not tell how the oxygen is combined offers scanty evidence from which to draw conclusions.

A fractional method for oxygen determination in steel has recently been advocated by Reeve[16] which may give some hints as to the mode of combination of the oxygen, but no results of the application of the method to cast iron have been reported.

The application of residue methods for determination of oxides, silicates, etc., in steel is difficult and doubtful enough without the added complication that would be caused by the graphite in cast iron. Adding an excess of aluminum to molten steel and determining the aluminum oxide formed, as suggested by Herty and recently modified by Kinzel and co-workers,[17] might have application to cast iron, but would give only total oxygen.

The idea that the total oxygen content would prove the key to the heredity problem is not yet proven correct and the chances seem to be strongly against a clear-cut answer from that mode of attack.

Lavagna[18] also discusses the heredity problem, and mentions, among other theories, that oxygen may have something to do with it and that a method for reducing the oxygen content is to heat above 2550° F.

LeThomas[19] also ascribes differences in cast iron to melting conditions that may affect the degree of oxidation.

Chubb[20] collects information leading to the belief that there are considerable quantities of oxygen in pig iron, combined as inclusions, whose composition may vary with the way the iron is smelted.

There is the possibility that the alleged heredity is not entirely tied up with the initial structure of the pig iron or with the content of oxygen or other things not shown by the usual analysis, but resides largely in the melting conditions, to changes in which different irons do not respond the same. The temperature to which the melt is heated is an obvious variable.

Elliott,[21] the pioneer in electric furnace refining and superheating of cast iron, whose work dates from 1917, found that besides fluidity from the temperature and a reduction of sulphur content from the use of a basic slag in basic furnace practice, the electric furnace products had much better strength.

Piwowarsky[22] brought forth in 1925 the idea that superheating cast iron above the temperature normally attained in the cupola produces major changes in structure and properties. For the irons he studied, there was an increase in combined carbon with temperature and time of superheating (casting temperature and rate of cooling remaining the same), and with still higher times and temperatures, a reversal toward the original amount of combined carbon. This was ascribed to the presence in the melt of two kinds of molecules, one of which led to graphite formation, the other to carbide formation on freezing, the proportion of these molecules, or their degree of dissociation, varying with temperature and time.

Bardenheuer and Zeyen[23] found that superheating in a high frequency furnace increased the strength of high carbon irons with normal silicon and manganese, but tended to decrease the strength of those with about 2.5% carbon, unless silicon was added to change the composition.

Saeger and Ash[24] found that some irons were helped and others injured by superheating, and in discussion, MacPherran stated that low carbon irons are injured. Meyer[25] studied a number of compositions melted in several types of furnace and in most cases found first an increase and then a decrease in combined carbon as the furnace temperature was raised, though some exceptions were found.

Hanemann[26] doubts Piwowarsky's explanation as to the presence of molecular carbide in the melt, assembles Piwowarsky's data and those of Meyer on the basis of carbon and silicon content, and finds that the two samples of Meyer's irons that did not show a decrease in combined carbon after being taken to the highest temperature are above the limit of the "stable saturation curve," while his other samples, and Piwowarsky's, are below it. He then concludes that the thing that is happening on superheating is the solution of graphite particles in the melt. Until all are dissolved, they will act as nuclei for separation of primary graphite.

However, if the presence of graphite nuclei is the whole story, one would expect that after their solution was complete, superheating to a still higher temperature would be without effect if the pouring temperature and cooling rates were held the same.

Piwowarsky[27] later became more specific in his explanation of the phenomena and relied upon the gradual disappearance of graphite nuclei in the melt with superheating for the behavior up to the temperature of reversal, where combined carbon starts to fall off, but is not very clear in his explanation of this reversal, apparently relying chiefly on the postulated presence of molecular iron carbide in the melt, which dissociates increasingly with increased temperature, this factor, only, acting after the last trace of graphite has dissolved. However, he also toys with the idea of increased gas solubility at the higher temperatures as a possible factor.

Still more recently, Piwowarsky[28] himself has presented evidence that graphite solution takes place very rapidly just above the liquidus and thus materially undermines the theory of kish in ordinary cast iron and its solution or retention as the major cause for the superheating phenomena.

Rosenhain[29] has commented on the shakiness of the graphite nuclei theory as the sole cause.

The graphite nucleus theory seems to be held, or approvingly referred to by many writers[30] on the subject. Thus, a refining of the graphite and an increase in combined carbon produced by superheating due to solution of traces of kish held in the melt, is the explanation most commonly adduced for the production of fine graphite in nodular form with higher combined carbon (the so-called supercooled or fine structure) on melts that have been superheated, in contrast with coarse graphite and less combined carbon (so-called normal structure) for melts that have not.

Jungbluth[31] reviews the subject of superheating at

Table 1. Piwowarsky & Heinrichs

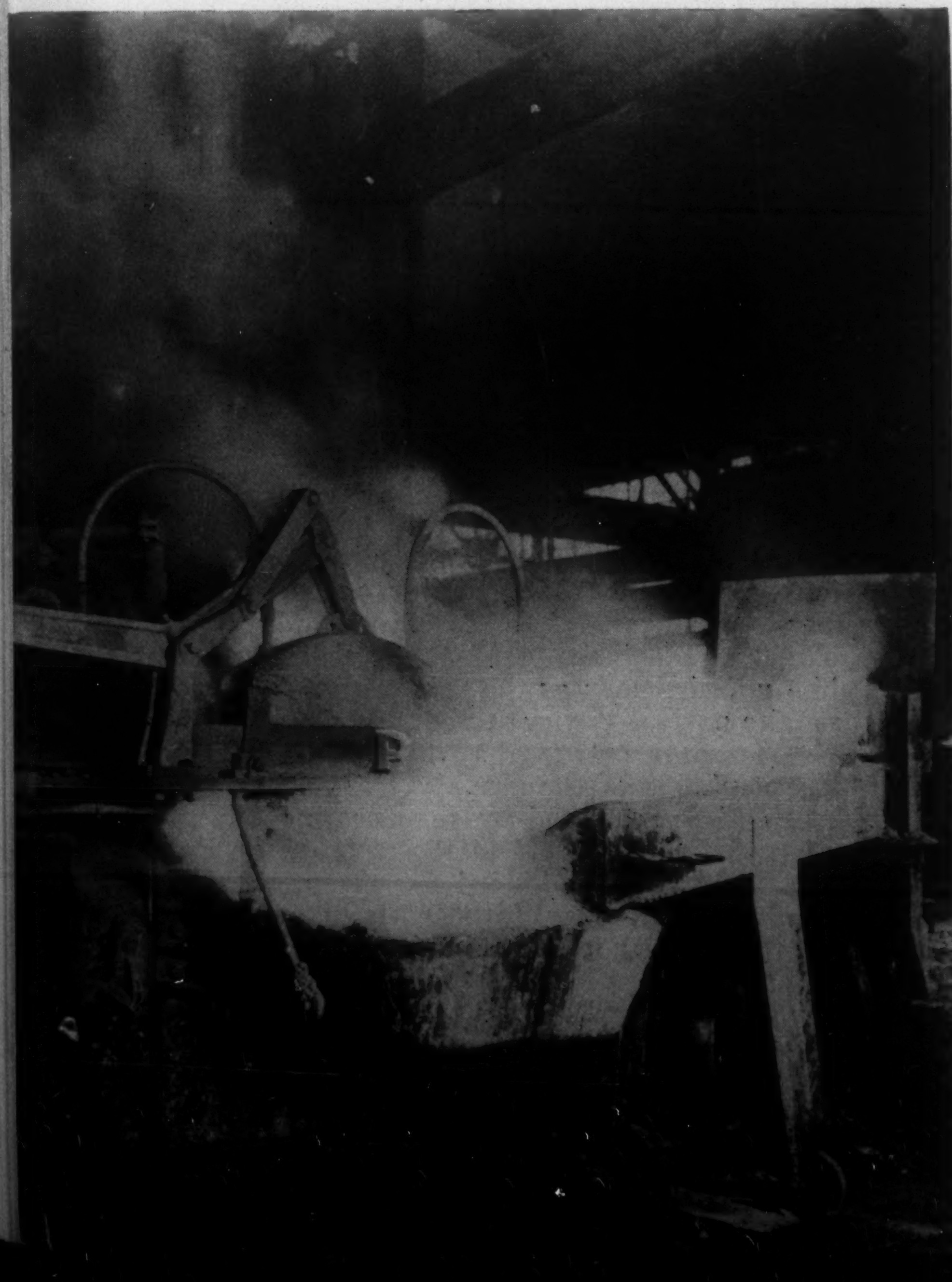
	T. C.	Graphite	Si	Mn	P	S	SiO_2	Al_2O_3	CaO	MgO	Fe_2O_3	MnO	S	Furnace Temp. ° C.	Tensile kg./mm.^{2}	Transverse kg./mm.^{2}	Deflection mm.	Brinell
A	3.14	2.32	2.05	.68	.17	.09	47.7	10.8	16.9	8.6	4.8	.4	0.6	1465	27.1	59.0	9	217
B	2.80	2.04	1.96	.71	.16	.06	5.3	0.3	71.5	4.5	6.8	—	0.3	1465	30.3	58	9	229
C	3.00	2.16	1.99	.71	.22	.04	21.8	9.4	54.9	10.0	2.0	.2	1.6	1495	32.8	66	12.5	248
E	2.98	2.14	1.87	.56	.18	.04	2.5	0.1	69.3	3.6	2.5	.1	0.6	1460	38.0	76	13	235
F	3.00	2.06	1.98	.64	.18	.07	6.8	6.8	65.9	12.8	4.4	.2	.07	1490	35.9	67.6	11	241

A. High alumina slag. B. Lime slag C. Lime fluorspar slag E. Lime, CaC_2 slag F. Lime, CaC_2 slag

considerable length and comments on the great difficulty of being certain of the facts and of choosing among the theories.

In a private communication commenting upon a draft of this abstract, Dr. J. T. Mackenzie has mentioned that someone, probably John Shaw, had pointed out the possibility of Piwowarsky's irons reacting with his crucible at the most elevated temperatures he used, and that the reversal of behavior might have been due to actual changes in composition. Dr. Mackenzie further comments that, though the mechanism of the loss is not clear, high superheating consistently results in a loss of carbon, and that there also appears to be unexplainable carbon loss or segregation in large, slow cooled castings when compared with one of thin section that freezes rapidly. Certainly the basic facts need to be soundly established by careful chemical analysis and before we theorize about "differences in behavior without change in chemical composition" we ought to be sure that the chemical composition actually is the same, and not be satisfied with stating that the same raw material was used.

Electric Furnace Installation, Showing Arrangement of Cupola Spout for Charging Melted Iron in Electric Furnace for Duplexing. (Courtesy Pittsburgh Lectromelt Furnace Corp.)



Both Dr. Mackenzie and Mr. J. W. Bolton, who also read a draft of this abstract, comment that ordinary grades of sand and chill cast pig iron used in this country behave, on melting, just as they ought from their final chemical composition, quite regardless of their source or previous history, so that to their minds the heredity talk seems overdone.

Irresberger[32] claims that jolting molten iron in a movable forehearth helps to dissolve the residual traces of solid graphite suspended in the melt and thus avoids the graphite nuclei that are supposed to start the separation of coarse primary graphite.

Stirring by agitation of the melt in a rocking type indirect arc electric furnace is stated[38] on the basis of tests at the Atlas Foundry Company, to produce finer graphite and higher tensile and transverse properties, without changing chemical composition. With the same superheat and the same charge, melts made with the furnace rocking gave better properties than those with it stationary.

Norbury[34] made crucible melts of irons made up from Swedish white irons, Armco iron, ferro-silicon, ferromanganese and ferrophosphorous, and found that materials of the same analysis and cast alike, had different structures, combined carbon, chilling tendency and mechanical properties, so that when he made up diagrams similar to that of Hanemann, he got, not one diagram, but two, one for materials giving the fine, supercooled structure and another for those giving the coarse, normal structure. He too, assumed that the normal structure is produced when graphite nuclei are present in the melt.

Norbury and Morgan[35] carried this work further, using a high frequency furnace, and found that the order in which the constituents of the charge were added had a marked effect on structure, etc. and was more important than wide variations in chemical composition.

If ferrosilicon was added last, the coarse graphite structures were obtained. Such an iron remelted with the addition of only 1½ percent steel, which did not appreciably change the composition, gave the fine "supercooled" graphite. This material, again remelted with addition of 0.03 percent flake graphite, gave coarse graphite again.

Various additions were made to whiteheart malleable cupola metal.

Additions of iron oxide, as scale, to crucible melts changed the chemical composition by oxidation, but produced no change in structure or properties that could not be accounted for from composition.

Norbury used calcium silicide without finding any very marked effect from its use. This brings up the matter of the so-called "Meehanite" iron, an iron made with a high steel content of the charge, and treated

Induction Furnace at U. S. Pipe & Foundry Co.
(Courtesy Ajax Electrothermic Corp.)

with calcium silicide, which according to Smalley,[36] need not be held within the strict composition limits as to silicon usually required with low carbon, high test irons, in order to secure high test results. He states that little or no calcium is left in the finished iron, and the silicon increase due to the use of calcium silicide is normally under 0.10%. A graphitizing action with the graphite appearing in very finely divided form, is claimed for the use of calcium silicide in the ladle.

Piwowarsky and Heinrichs[37] studied the effect of various modifications of basic slags on the refining of cast iron from sulphur and on the properties, in commercial direct arc electric furnace operation. Specimens were cast when the charge had reached temperatures from 1420° to 1510°C. through the refining period. The highest strengths were obtained at about 1465°. The casts were not cooled down to the same temperature before pouring. The 1465° or thereabouts pour was made about 25 minutes after an addition of ferrosilicon. The properties of the specimens cast at this period are given in Table 1.

Piwowarsky and Heinrichs noted that the tendency away from coarse, net-work, needle-like graphite and toward short needles and the temper-carbon type of graphite increased with increasing temperature up to the maximum used, 1510°C.

While so many variables were involved in the different slags and temperatures studied that sweeping conclusions are difficult to draw, Piwowarsky and Heinrichs concluded that slags higher in oxygen (reported as Fe_2O_3) were detrimental for refining of cast iron at high temperatures, and that unsuitable slags may nullify or overbalance the beneficial effect of superheating. They point out that high test cast iron should be handled with the same careful choice of slags, based on proper fundamental laws, as is done in the smelting of iron or the refining of steel.

TABLE 2

Slag	Furnace Temp. ° F.	Pouring Temp. ° F.	C %	Comb. C %	Graphite %	Si %	Mn %	Tensile Strength lbs./in.²	Brinell
All glass	2750	2590	2.44	1.14	1.30	2.86	0.24	21500	258
½ glass ½ scale	2750	2570	2.44	1.16	1.28	2.59	0.22	38000	263
All glass	2730	2570	2.34	1.09	1.25	2.69	0.20	21000	263
All glass	2770	2625	2.57	1.09	1.48	2.68	0.27	32000	244
½ glass ½ scale	2785	2625	2.47	1.06	1.41	2.60	0.26	39500	256
All glass	2730	2600	2.47	1.04	1.43	2.61	0.25	36500	258

The melts contained about 0.07% each of S and P.

From all of this, we see that, while Norbury's experiment in which the addition of 0.03% graphite seeded out coarse primary graphite tends to show that graphite nuclei *can* have this action, it is none too likely that such nuclei *do* exist in commercial high test iron. The reversal of the amount of combined carbon in Powowarsky's early experiments remains but feebly explained.

The earlier idea of J. E. Johnson, Jr. that oxygen was the root of the differences in behavior of irons of the same composition strikes the snag of difficulty of oxygen determinations, and the question whether they

Tilting "Teapot Spout" Ladle Pouring Direct Into Sand Molds. (Courtesy Pittsburgh Lectromelt Furnace Corp.)

would throw any real light on the problem unless the mode of combination of the oxygen is known, as well as its amount.

There still recurs in the articles and discussions the idea that maybe oxygen in some way does play some rôle, perhaps most forcibly brought out by Piwowarsky and Heinrichs.

But quite unexplained are the observation of Norbury that the order in which the components of the charge were added, was a controlling factor in the structure produced, and that of Judson that mixing of two molten irons to produce a given composition gives different results than one melt of that composition. The observations on heredity of pig to casting and the anomalies of reversal of structure on adding a very little steel do not seem adequately covered by explanations of superheating and graphite nuclei or of total oxygen.

O. v. Keil[38] attempted to straighten some of these matters out by reference to the double diagram, i.e., the graphite and the cementite equilibria. He classified irons as those that both on freezing and melting show the eutectic points in the cementite system as freezing white, without primary graphite, those that show the cementite eutectic point on freezing but the graphite point on melting as producing fine nodular (graupelig) graphite, while those that show the graphite eutectic point both on freezing and melting as giving coarse needle-like graphite. Intermediate stages between the two latter would cover some of the cases discussed by various authors.

Piwowarsky[39] finds that if he raises the superheating temperature, the eutectic temperature observed on cooling is lowered. He also makes the interesting observation that if the iron is allowed to freeze directly after making silicon and manganese additions, the eutectic temperature is lowered, but if the metal is held molten for a time this effect disappears. The greater the lowering of the eutectic temperature, the greater is the tendency to produce combined carbon rather than graphite. One wonders whether the silicon and manganese are not forming inclusions that agglomerate as time goes on while the metal is held molten.

Superheating of white iron for malleableizing is stated by White and Schneidewind[40] to induce supercooling (a lower freezing point) and an increasing tendency of the white iron to graphitize on annealing, with the production of more, but smaller, temper carbon nodules.

Quite recently, v. Keil and co-workers[41] put forth the interesting idea that neither graphite nuclei nor total oxygen govern whether the cast iron will show coarse, primary graphite or fine nodular graphite resulting from break up of cementite, but rather the presence or absence of a "ferrous silicate slime," a submicroscopic suspension of finely divided silicate slag particles.

That sub-microscopic particles may exist in solid or liquid metal and vastly affect their performance is not difficult for present-day metallurgists to believe, in view of what is known about precipitation-hardening alloys, and about the effect of the addition of aluminum, titanium, vanadium, etc. to steel for producing controlled grain size and resistance to aging. While there are two schools of thought, one feeling that it is the degree of removal of ferrous or manganous oxide that governs grain size and aging, the other, and probably the more numerous one, considers these phenomena to be due to the presence of a "fog" of sub-microscopic non-metallic particles which obstruct grain growth.

The work of Herty and his associates has thrown light on the effect that temperature, composition of deoxidizer, composition of slag, degree of stirring and size of particles, exert on the formation, retention or removal of finely divided non-metallic silica, alumina or silicate particles in suspension in molten steel.

If the postulate be accepted that a similar swarm of particles exists in some cast irons, and that such particles can act as nuclei for the separation of primary graphite on freezing, and that they may be agglomerated and floated off by superheating and stirring instead of suspended kish being dissolved, then some of the other observations on heredity and order of addition of the materials in the charge might fall into line.

A pig iron without the "silicate slime" would melt down to the type of iron that doesn't produce coarse graphite, unless some addition were made or treatment given to introduce a slime, while a pig that started out with the slime would not be freed from it unless superheating or some addition that would tend to flux the slime were resorted to. If not disturbed, each type would show "heredity."

Anything that tends to form in or to add to the melt FeO or SiO_2 under such conditions that the one can react with the other that was previously there would tend to produce this one kind of slime or submicroscopic inclusion that would serve as nuclei for graphite separation. The small amount of FeO that would be carried in by a steel addition such as Norbury and Morgan made might be just enough to flux out the slime that was present.

From this point of view the nature of the deoxidizers added, the order of their addition, as well as the temperature and time at temperature, the presence or absence of stirring, the nature of the slag, and its oxidizing power upon the metal, the hearth or crucible from which Si might be reduced to enter the melt, and the nature of the furnace atmosphere, reducing or oxidizing, would all be factors that could not be neglected.

If a super-heated iron-carbon melt is freed from FeO by deoxidation with Al, Mn, Mg or Ca, and then the silicon is added, v. Keil and co-workers find that metastable freezing only occurs to cementite, the frozen material showing only nodular graphite. Such cases are shown for example in melts containing

C	Si	Mn	Ni	Order				Cooled at ° C./min.
3.10	3.2	—	—	C,	Si	s*	Si added before superheating	7.3
2.90	5.4	—	—	C,	Si	s		7.3
3.40	2.5	1.0	1.0	C,	Si,	Ni	s	25

* s = superheating

which showed only nodular graphite, no needles. If similar superheating was carried out but the Si and Mn added afterwards, as in:

C	Si	Mn	Order				Cooled at ° C./min.
1.82	3.1	—	C,	s,	Si		30
2.30	3.0	1.0	C,	s,	Mn	Si	28
2.00	3.0	1.0	C,	s,	Si	Mn	27

the specimens showed graphite separation in needles, even though the carbon was low.

If, however, the Fe C melt is deoxidized with Al before superheating, and Si then added, or if not superheated but fully deoxidized before the Si is added, as in

C	Si	Mn	Ni	Order					Cooled at ° C./min.
2.75	4.7	—	—	C,	Al,	s,	Si		10
3.00	3.0	—	1.0	C,	Ni,	Al,	Si		25
3.20	3.0	0.5	—	C,	Mn,	Al,	Si		23
3.68	3.0	0.45	—	C,	Al,	Mn,	Si,	s—more Si	—

the specimens showed no needles, only nodular graphite.

It was found that a melt of C—3.8, Si—1.16 and

Mn 0.74 deoxidized with 0.03% of an alloy of 90% Al, 10% Mg still froze with needles of graphite, but on using 0.06% of the deoxidizer, it gave only nodular graphite.

An iron with 3.40% C, 3.15% Si which, when superheated, froze free from needles of graphite was superheated and then blown with air at 1350°, till the C fell to 3.37% and the Si to 2.82%, but still froze free from needles.

The addition of roll scale to a 4.17 C, 1.32 Si, .85 Mn, .17 P, .01 S charcoal iron which, without the scale gave fine nodular graphite and a few needles, did not change the graphite. But when this was diluted with 23% of electrolytic iron (which doubtless contained oxide), it gave plenty of needles with only traces of nodular graphite. Experiments with other charcoal irons and smaller amounts of electrolytic iron gave similar results. Apparently FeO to react with Si of a "slime-free" melt, so as to form the harmful "silicate slime," has to be introduced in a rather dilute form. Larger doses are thought to be removed by slagging in large particles rather than to remain suspended.

Slagging action was then studied. A pig iron of 4.03% C, 3% Si, 0.5% Mn that when melted without contact with slag, gave coarse needles on freezing, was held 10 minutes under slags at 1400°C. Under a slag of 69% SiO_2, 17% CaO, 14% Al_2O_3, it lost carbon down to 2.95% C. Under a slag of 46% SiO_2, 44% CaO, 10% Al_2O_3, it lost carbon down to 2.78% C. The graphite was finer than in the original slag-free melt, but still not appreciably nodular. But when a more basic slag of 37% SiO_2, 54% CaO, 9% Al_2O_3 was used, carbon was not lost and the graphite was overwhelmingly nodular with some fine needles and a very few coarse ones.

Reduction experiments were then made with iron ores and slags in a graphite crucible, and it was found that the coarsest graphite resulted with a slag of 34.5% SiO_2, 53% CaO + MgO, 12.5% Al_2O_3. With a very acid slag of 73.5 SiO_2, 8.5 CaO + MgO, 18% Al_2O_3, the graphite was in fine needles and in nodular form. With a highly basic slag 29.5% SiO_2, 59.5% CaO + MgO, 11% Al_2O_3, the graphite was all nodular.

Sponge iron was then melted with charcoal under slags of varying basicity to produce synthetic irons of 4.4 to 5.0% C, 1.2 to 2.2% Si. The graphite was the finer the higher the basicity. On the whole, it was concluded that the composition of blast furnace slag must have a large effect upon the "heredity" of pig irons, and that either an acid or a highly basic slag will lead to finer graphite than a more nearly neutral slag. Highly basic slags are hardly feasible in the blast furnace, but the acid slag of the charcoal furnace is suggested as the cause for the superiority of charcoal iron.

As a check upon this, tests were made with a 7.5 ton direct arc furnace. In heats having the same melting time, one under the usual $CaO\text{-}SiO_2\text{-}CaF_2$ slag picked up 0.25% Si and the bending strength of the iron was only 38 kg./mn.^{2}, while under a $CaO\text{-}CaF_2$ slag, the charge lost 0.05% Si, gave nodular and fine-needle graphite, and a bending strength of 55 kg./mm.^{2}

It is then concluded that very finely divided submicroscopic iron silicate suspensions are responsible for coarse primary graphite. To avoid such suspensions one may use iron originally free from them, and avoid introduction of FeO or SiO_2, or if present, they can be destroyed by Mg or Ca, or by superheating with suitable slags.

While v. Keil's hypothesis can only be proven by indirect Sherlock Holmes methods, because it depends on a postulated sub-microscopic suspension, the idea is interesting and offers some promise of reconciling some of the facts that stubbornly resist explanation on the basis of former theories. Whether or not it will explain all of them, and come to ultimate acceptance, it at least opens a field for experimental attack that should perhaps establish it, more probably lead to further modifications until, some day, the mystic "heredity" of pig iron becomes understandable, and hence, controllable.

The idea of non-metallic inclusions acting as nuclei for graphite separation is not entirely new, for Bolton[42] long ago noted that graphite flakes were likely to contain sulphides and suggested that sulphides should have an effect on nuclei formation. In consideration of von Keil's suggestion, Bolton's idea of sulphide nuclei also needs attention.

It will be recalled[43] that sodium carbonate, used to remove sulphur, is also alleged to produce fine graphite. Its fluxing action might be expected to be exerted upon silicate inclusions and thus to affect their size and distribution.

That reactions go on between pig iron and slag is brought out by Dinkler[44] who finds that with an acid slag, much SiO_2 and no MnO_2 is reduced in the hearth, while if the slag is basic, the conditions are reversed.

Bardenheuer and Reinhardt[45] made a systematic study of the effect of slags rich in iron oxide, obtained by adding mill scale, and of acid slag low in iron oxide, i. e., glass, upon a range of cast irons of high and low carbon and silicon, which were superheated to 2700° to 2900° F. in contact with the slags.

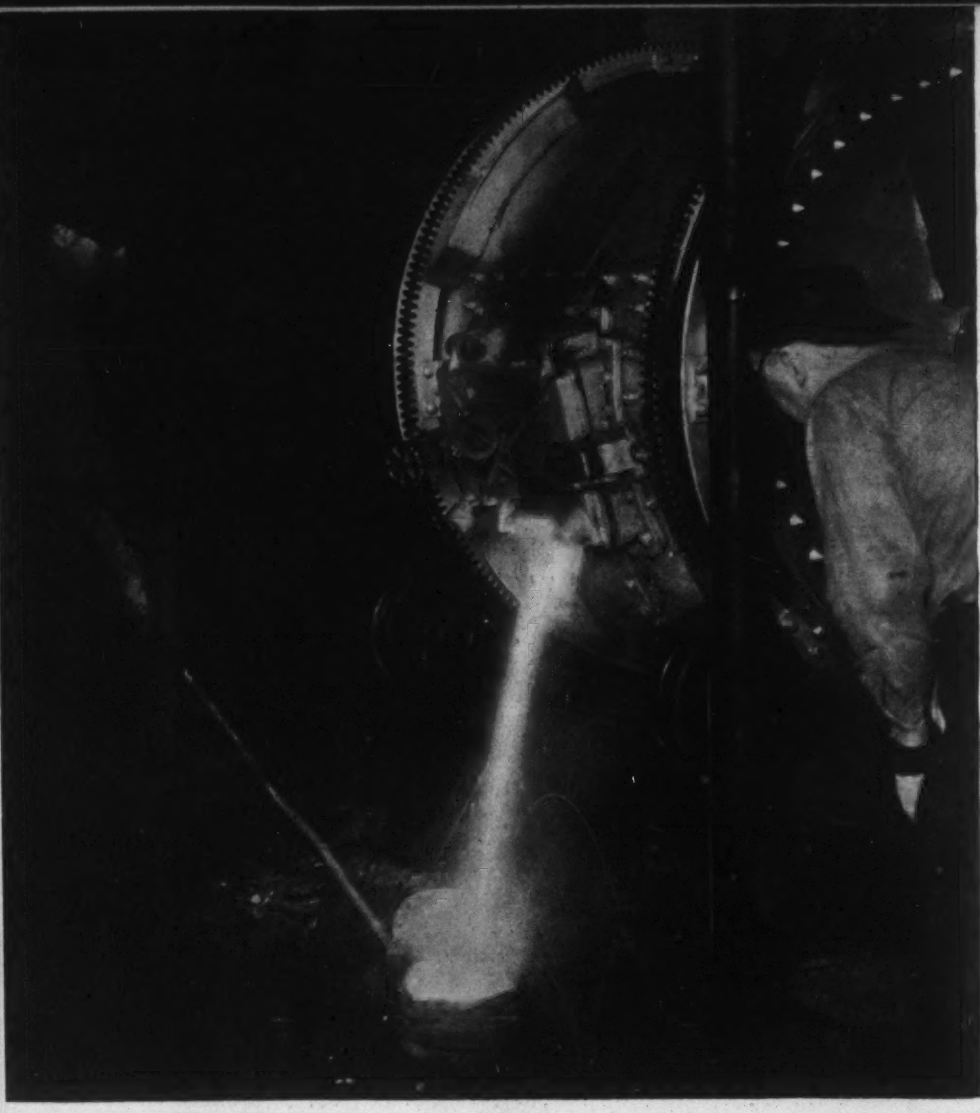
Composition and amount of superheating of an iron being the same, different results were obtained with different slags. The slag high in iron oxide made the melt freeze at a higher temperature (as much as 55° F. higher in one case cited), without supercooling and thus with coarse graphite. The glass slag made the irons treated with it show undercooling. Their strength and hardness varied with the carbon and silicon. With high carbon and low silicon the hardness was higher on the melts treated with a glass slag, than on those treated with the iron-oxide slag.

By picking out the low values with the glass slag and the high values with the iron oxide slag the plotted results indicate a quite startling effect of an oxidizing slag on improvement of tensile and bending strength on the lower carbon contents. But some of the duplicate tests under the glass slag, tabulated but not plotted do not show up as clearly. For example, in two heats, the following results were recorded.

If we compare the lots treated with glass plus scale with the first and third, without scale, the scale seems to have a great effect, but if the comparison is made with the last one in Table 2, the effect is not so striking.

Oxygen determinations were made, and ran from 0.002% to 0.008% with the higher oxygen values usually for the specimens treated with iron oxide slag, but not always so, so that one would be hard put to figure that the oxygen determinations indicate anything conclusive.

It is quite evident that the heredity problem is very involved. The theory of persistent kish and its solution, a theory attractive because of its simplicity, seems none too well grounded. That of submicroscopic silicate or oxide nuclei is difficult of direct proof and it



Rocking Electric Furnace at Atlas Foundry (Courtesy Detroit Electric Furnace Company)

is by no means certain that it explains all the phenomena.

While superheating and stirring to dissolve kish or superheating, stirring and slagging to agglomerate or to disperse non-metallics, do not produce the same effect upon irons of different compositions, yet they offer methods of attack that may well be tried when a given pig iron seem to show "hereditary tendencies" and a reluctance to act as we would expect from its composition. Whether a theory that leads us to try out something that we might not try without the hope of improvement that the theory holds out, is a correct theory or not is of little moment if the trial leads to a solution of the difficulty.

Yet we must hope for and search for an entirely correct theory, for were such a theory evolved and proven, one could use it with certainty to lead him to an immediate solution of his difficulties rather than merely as a guide for experimentation in each recurring case.

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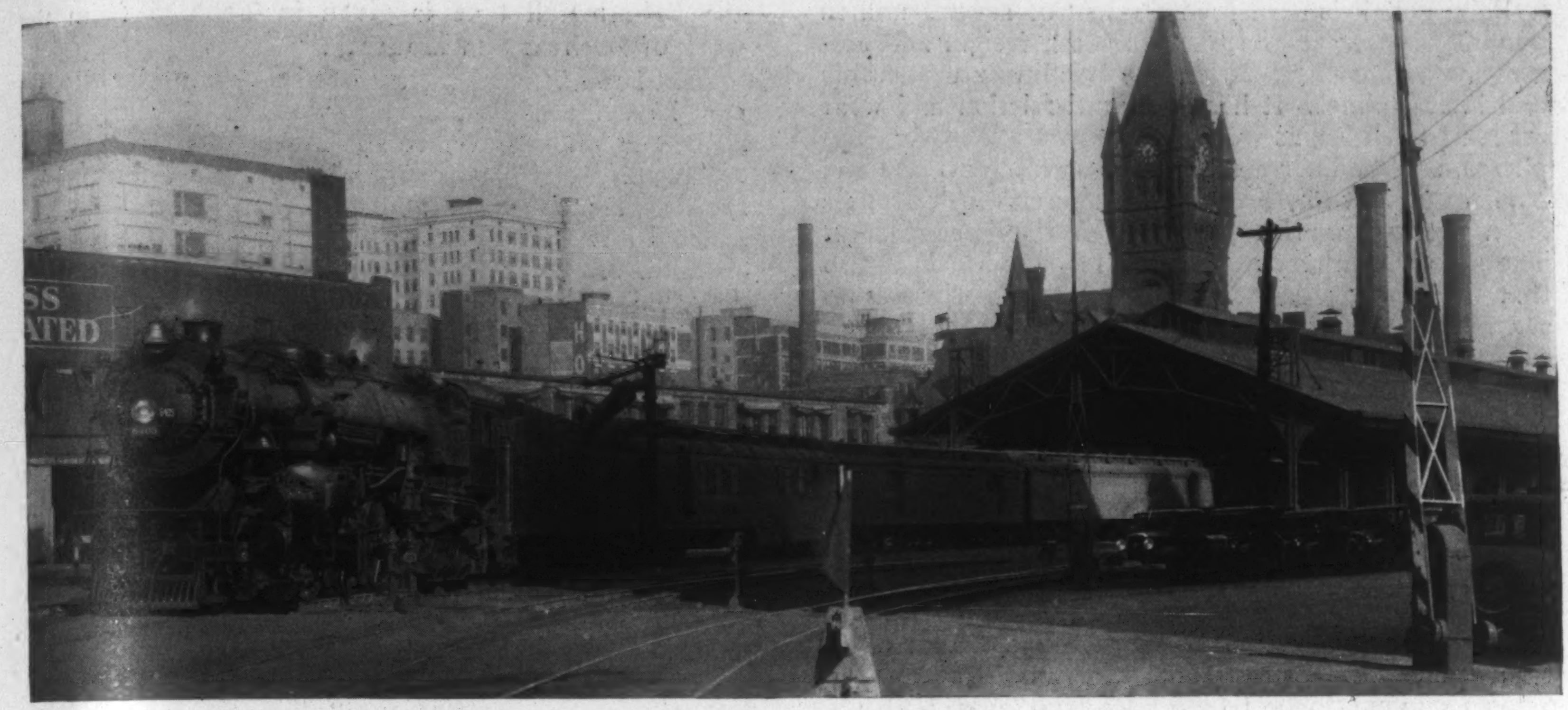

The Famous Transcontinental Olympian Taking Water at Milwaukee

BEARING METALS

of Lead Hardened with Alkali and Alkaline Earth Metals

By Leland E. Grant ‡

(Continued from the August Issue)

Methods of Manufacture

Various methods have been proposed and patented for alloying the alkali or alkaline earth with lead but only the electrolytic process has been used commercially. In this process an iron pot, set in brick work, is filled with lead and the metal melted. A low melting point mixture of calcium and barium chlorides is put on the molten lead and a graphite anode set in the center of the pot. Electrolysis at 10 volts is carried on for about 3 days or until sufficient barium and calcium have been reduced from the chlorides and alloyed with the molten lead. The alloy thus produced is added to commercially pure lead in sufficient amounts to bring the barium and calcium up to the desired values. This is the method that was used in making Frary metal. Recent investigations by Ray[16] indicate that this method is more satisfactory than many others that have been proposed. Ray's paper contains a brief discussion of some of the other methods that have been used for preparing alloys of this type. Betterton[31] has obtained patents on improvements to one of the older methods which may result in the electrolytic process being discontinued. Betterton makes use of a carbide or carbides of the alloys to be introduced into the lead and a protective slag of chlorides on the bath to prevent oxidation. Mechanical agitation is provided to bring the carbides into intimate contact with the lead. The process appears to be rapid as well as economical.

Table 3. Composition

Element	Frary	Satco†	Lurgi	Bahn-metall	Can
Pb	97.5	Remainder	96.5	98.63	94.9
Sr	.....	.....	.....	.....	1.0
Ba	<2.0	.....	2.8	.....	1.0
Ca	<1.0	0.15	0.4	0.69	1.75
Na	.....	.....	0.3	0.62	Tr.
Li	.....	.....	.....	0.04	.....
Hg	0.25	.....	.....	.....	.....
Al	.....	.....	.....	0.02	.....
K	.....	0.07	.....	.....	.....
Sn	.....	2.40	.....	.....	.....
Cu	.....	.....	.....	.....	1.35

Brinell Hardness

Temperature °C.	Frary	Satco†	Lurgi	Bahn-metall	Can
25	29.6	26*	30–32	25–35*	27–30
50	27.2	.....	26**	22**	25**
100	20.9	15.7	17.4**	17**	16.5**
150	14.0	19.1	10.5**	12**	11.5**

Pouring Temperature °C.

Frary	Satco†	Lurgi	Bahn-metall	Can
	500–540	410–440	470–600	620–730

As a result of the work that has been done in an effort to make good bearing metals by alloying the alkali and alkaline earth metals with lead there are at present 4 alloys in service. Three of these are used in Germany and one in the United States. The composition and properties are tabulated, along with those of Frary metal in Table 3. For convenience in making comparisons the A.S.T.M. lead and tin base alloys are shown in Table 4. The data on Lurgi, Can, and Bahnmetall are from information supplied by Dr. Kuhnel. Chief Federal Railway Councilor, Germany.[27] The analysis of Satco is that reported by Karelitz and Ellis[17], while the physical properties are from the manufacturer's literature. Karelitz and Ellis state that Satco has about the same properties as their alloy of 90 Sn, 8 Sb, and 2 Cu. The properties of this tin-base alloy are as follows:

Brinell Hardness	Temp. C.°
21.7	21.5
16.2	50
10.2	100
8.1	125
Ultimate Strength (compression).....	15,200 lbs./in.^{2}
Yield Point	9,900 lbs./in.^{2}

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‡ Chief Chemist, Chicago, Milwaukee, St. Paul & Pacific Railroad Company.

† This is the composition given by Karelitz and Ellis[17] in 1930. Darby[29] refers to it as lead with small amounts of tin and aluminum. Schoemaker,[30] the proposer of this alloy, refers to it as containing about 98% Pb in combination with Ca, Sn and other materials.

* These values at 20°C.

** These values were with a 200 kg. load and a 10 mm. ball; all other values were with a 500 kg. load and a 10 mm. ball.

Bahn-metall is used to the extent of several million pounds annually in Germany for both freight and passenger car bearings, as well as for lining crossheads and lateral plates. It has good anti-friction and wear resisting qualities, as well as the advantage of easy application. The liner can be cast accurately to size and applied without any broaching. There is little trouble from bearings running hot under these conditions. The small lithium content promotes stability in air so that the bearing neither oxidizes nor deteriorates in storage. Lining of bearings with Bahn-metall requires careful foundry practice which differs in many details from that of the usual Babbitt practice. It, therefore, becomes impractical for the ordinary railroad shop to reline its own bearings. It is necessary to ship them to some point where the proper shop facilities are available.

That oxidation is a serious item in melting and casting these alloys is indicated by the statements of Rolfe in his discussion of a paper on calcium by Brace.[18] He gives the following analysis of a proprietary alloy (apparently Frary metal) in which he indicates the oxygen content to be 0.66%: Pb 97.05, Ba 1.30, Ca 0.79, Fe 0.11, Cu 0.04, Zn 0.04, As 0.01, Ni trace. The oxygen content is by difference and no determination of mercury was made. This leaves some doubt as to all of the difference actually being oxygen. Since Frary metal contains only about 0.2% of mercury and as a total of 14 elements were determined it does seem that some of the 0.66% must have been oxide. Rolfe found much drossing in melting, more than with the tin-base metals, and he could not advise keeping a pot of it molten. It should, however, be borne in mind that alloys of this type must be poured at a relatively high temperature, 450°-600° C. and oxidation of any of the common white metal bearing alloys would be rapid at such temperatures. Brace[18] experienced so much difficulty with oxidation in casting thin sections that he could not use the metal.

The alkali-alkaline earth-lead alloys are subject to more shrinkage in solidification and have a higher coefficient of expansion than the ordinary lining metals and this is likely to cause difficulty unless precautions are taken. The coefficient of expansion of an alloy of the Bahn-metall type is given in Table 5 from the work of Bochvar and Maurach.[19]

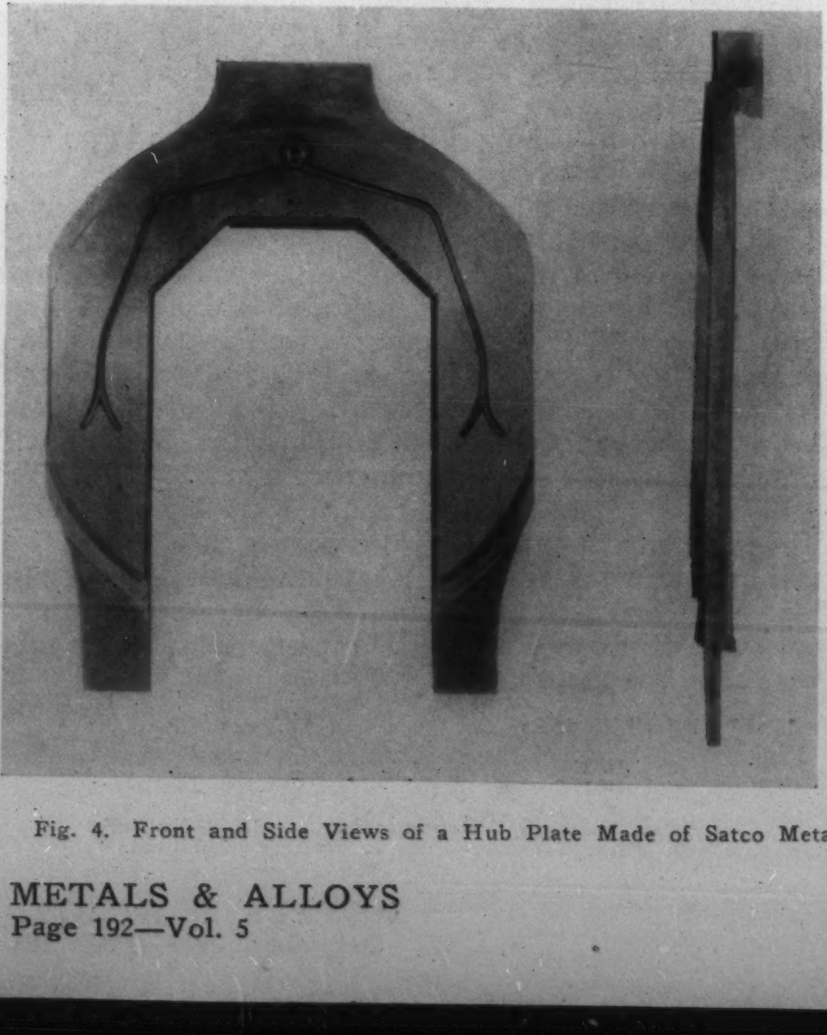

Fig. 4. Front and Side Views of a Hub Plate Made of Satco Metal.

All of the bearing metals of the type under discussion have the additional disadvantage of being easily spoiled by the admixture of either lead- or tin-base bearing metal. Kroll[20] found that the addition of alkali or alkaline earth metals to lead or tin alloys resulted in the precipitation of arsenic, antimony and bismuth. If the proper precipitation agent were used the elimination was quantitative, the process being very similar to that taking place in water solutions. This method is being used commercially for removing bismuth from lead. Tin, copper, lead, zinc, cadmium, and the noble metals were not subject to this reaction. Obviously, the two types of bearing metals should not be mixed or there will be considerable loss of the hardening elements.

Alloys comparatively high in alkali or alkaline earth metals are not readily anchored to the usual backs and must have mechanical anchorage, in addition, for satisfactory service. Owing to the high casting temperature it is necessary to heat the backs to a fairly high temperature and to "tin" them to improve the adherence. This is not true of Satco, however. It is less highly alloyed and does not contain any alkali metals so that bearings can be lined with this metal in the usual way using an 80-20 lead-tin solder. The adherence is as good as it is for the ordinary lining metal. Satco contains an appreciable amount of tin as one of the hardeners and but little of the alkali and alkaline earths so it perhaps ought to be classified as something of a hybrid.

The hardened leads have not attained any widespread application in the United States. Frary metal was used to some extent for street car bearings[26] and other work but has now been completely displaced by Satco which has better properties. Frary and Temple[32] reported some very interesting tests which were made to show the good properties of Ulco metal, as the Frary alloy was known commercially, but nevertheless it was not entirely satisfactory as a bearing, apparently on account of brittleness. The railroads and automotive manufacturers are making extensive tests with Satco but no definite conclusions can yet be drawn as to its proper field in these industries. One of the major railroads has used Satco quite extensively over a period of 2 years or more for such purposes as locomotive and tender truck bearings, hub liners, and passenger car bearings. They have had very good results with the metal generally. The life is so much longer than that of A.R.A. lining metal and the results so much superior that they believe the extra cost is made up many times by the improved service. Bearings operate under rather severe conditions on railroad cars. Lubrication is far from ideal from the very nature of the conditions. Loads are moderately high, being on the order of 400 lbs./in.^{2}, and the rubbing speeds are from 8 to 12 ft./sec. as an average. Lack of proper fitting of the bearing, unavoidable mechanical defects, and intermittent shocks in service all tend to produce excessive loading of the bearings. Any bearing metal that will give long and dependable service under these conditions has merit.

The Milwaukee Road has tested a few Satco hub liners, similar to those shown in Fig. 4 with good results in most cases. Some locomotive truck bearings lined with Satco have also been tested in comparison with genuine babbitt and the standard lead-base Babbitt. The results are somewhat contradictory and not extensive enough to warrant any definite con-

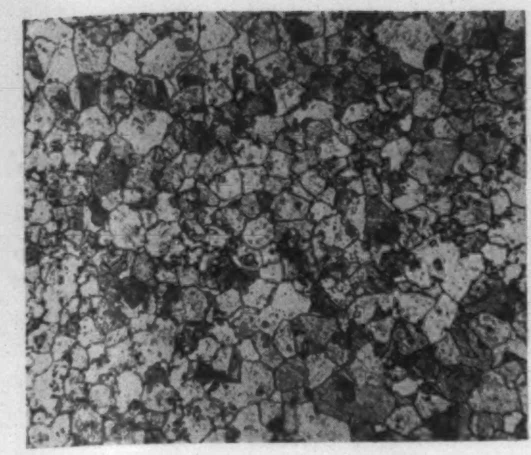
Fig. 5. Satco Lining Metal from a bearing that ran hot. Magnification 100X.

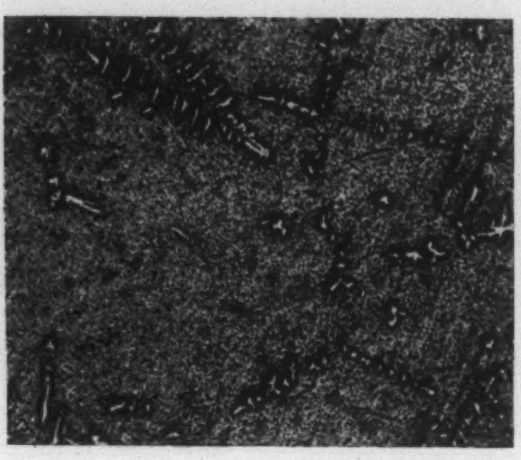
Fig. 6. Cast Satco Bearing Metal (Hard Type) Unetched. Magnification 100X.

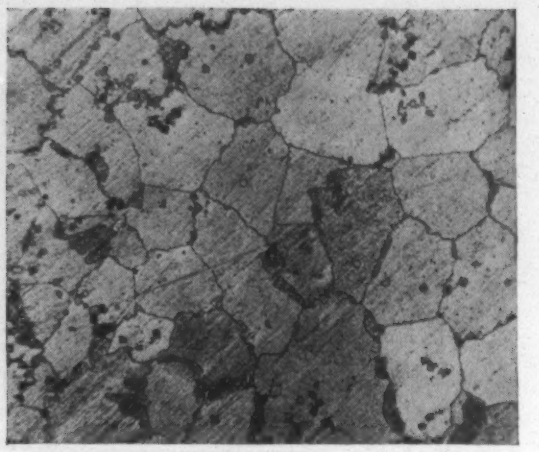
Fig. 7. Soft Type Satco Specimen as cast, 2-inch solid bar. Etched. Magnification 100X.

clusions. Fig. 5 shows the micro-structure of one of the bearings that ran hot and had the lining partially squeezed out. The normal structure of the metal is shown in Fig. 6, but it is not, however, characteristic of the Satco that is now being furnished. The present type of Satco is softer and less highly alloyed. The hardness is around 21 as compared with the 25 to 26 Brinell of the type shown in Fig. 6. (This difference in hardness must be taken into consideration in reading the literature as all of the results are for the harder alloy.) A change in microstructure is also evident. Fig. 7 represents the new type and shows much less of the massive crystals that appear in Fig. 6. The specimen for Fig. 7 was cut from a 2-inch solid bar of the metal and doubtless differs somewhat from what would be found in a thin section, rapidly cooled, such as the lining metal in a bearing. Also in the etched condition it does not show the calcium rich crystals as distinctly as when unetched. This softer, more ductile metal is undoubtedly less likely to develop cracks than the harder type. The hardened leads seem, as a class, to be subject to cracking particularly when alloyed to produce rather high hardness. Jakeman and Barr[21] found Bahn-metall to be subject to hair-line cracking in their tests.

Karelitz and Ellis made some running tests with Satco in comparison with tin-base babbitts but the load of only 200 lbs./in.^{2} at 7 ft./min. was too low to tell anything much about the serviceability of the metal. They did find that the wiping temperature was close to the solidus (320° C.) which emphasizes the high temperature the metal can endure without failure. This is probably one of the most important features that make the metal valuable for railroad service. It will withstand temporary local overheating without much harm being done.

Table 5. Linear Coefficient of Expansion of Anti-Friction Alloys

Sn	Pb	Sb	Cu	Other Metals	Coefficient $\times 10^{-6}$
100	...	...	...	......	23.50
83	...	12	5	......	24.20
16	65	16	3.0	......	26.50
14.4	69.4	13.5	2.7	......	27.40
4.9	75.5	14.7	2.9	......	28.40
...	81.5	17.0	1.5	......	26.50
...	98.9	...	...	0.6 Ca, 0.5 Na	36.30

In view of the early predictions that lead-alkali-alkaline earth metals would quickly displace the more costly tin-base bearing metals because of the superior properties it is interesting to consider some of the tests that have been made to determine whether or not such replacement was justified. Perhaps one of the most satisfactory of such studies is that made not very long ago by Jakeman and Barr in their general study of bearing metals and lubricants. They compared Bahn-metall with a tin-base alloy of the following composition; Sn 82, Sb 10.9, Cu 3.8 and Pb 3.1. The hardness values of the 2 metals were as follows:

Tin-base	22.5 Brinell
Bahn-metall	35.5 Brinell

Running tests at various loads showed the lead alloy to be unsatisfactory above 900 lbs./in.^{2} at a surface speed of 11.4 ft./sec. because the bushings either cracked or were squeezed out. The tin-base metal was satisfactory up to 2500 lbs./in.^{2} at the same speed. The alkali-lead metal, however, had a lower friction loss up to 65° C. bearing temperature with the above speed and load. The better anti-friction property was believed to be due to the greater hardness of Bahn-metall. At higher temperatures the conditions were

Table 4. Composition and Physical Properties [1] of White Metal Bearing Alloys

Alloy Number	Specified Composition of Alloys Cu %	Sn %	Sb %	Pb %	Specific Gravity	Compositions of Alloys Tested Cu %	Sn %	Sb %	Pb %	Yield Point,[2] lbs./in.^{2} 20°C.	100°C.	Johnson's Apparent Elastic Limit,[3] lbs./in.^{2} 20°C.	100°C.	Ultimate Strength,[4] lbs./in.^{2} 20°C.	100°C.	Brinell Hardness [5] 20°C.	100°C.	Melting Point °F.	°C.	Temperature of Complete Liquidation °F.	°C.	Proper Pouring Temperature °F.	°C.
1	4.5	91.0	4.5	...	7.34	4.56	90.9	4.52	none	4400	2650	2450	1050	12850	6950	17.0	8.0	433	223	...	...	825	441
2	3.5	89.0	7.5	...	7.39	3.1	89.2	7.4	0.03	6100	3000	3350	1100	14900	8700	24.5	12.0	466	241	669	354	795	424
3	8⅓	83⅓	8⅓	...	7.46	8.3	83.4	8.2	0.03	6600	3150	5350	1300	17600	9900	27.0	14.5	464	240	792	422	915	491
4	3.0	75.0	12.0	10.0	7.52	3.0	75.0	11.6	10.2	5550	2150	3200	1550	16150	6900	24.5	12.0	363	184	583	306	710	377
5	2.0	65.0	15.0	18.0	7.75	2.0	65.5	14.1	18.2	5050	2150	3750	1500	15050	6750	22.5	10.0	358	181	565	296	690	366
6	1.5	20.0	15.0	63.5	9.33	1.5	19.8	14.6	63.7	3800	2050	3550	1800	14550	8050	21.0	10.5	358	181	531	277	655	346
7	...	10.0	15.0	75.0	9.73	0.11	10.0	14.5	75.0	3550	1600	2500	1350	15650	6150	22.5	10.5	464	240	514	268	640	338
8	...	5.0	15.0	80.0	10.04	0.14	5.2	14.9	79.4	3400	1750	2650	1200	15600	6150	20.0	9.5	459	237	522	272	645	341
9	...	5.0	10.0	85.0	10.24	0.06	5.0	9.9	84.6	3400	1550	2400	950	14700	5850	19.0	8.5	459	237	493	256	620	327
10	...	2.0	15.0	83.0	10.07	0.12	2.05	15.7	82.0	3350	1850	2250	1200	15450	5750	17.5	9.0	468	242	507	264	630	332
11	...	...	15.0	85.0	10.28	0.19	0.09	14.8	84.7	3050	1400	2750	1100	12800	5100	15.0	7.0	471	244	504	262	630	332
12	...	...	10.0	90.0	10.67	0.12	0.11	9.9	89.4	2800	1250	2250	950	12900	5100	14.5	6.5	473	245	498	259	625	329

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[1] The compression test specimens were cylinders 1½" in length and ½" diameter, machined from chill castings 2" in length and ¾" in diameter. The Brinell tests were made on the bottom face of parallel machined specimens cast in a 2-in. diameter by ⅝-in. deep steel mold at room temperature.

[2] The values for yield point were taken from stress-strain curves at a deformation of .125% reduction of gage length.

[3] Johnson's apparent elastic limit is taken as the unit stress at the point where the slope of the tangent to the curve is 1½ times its slope at the origin.

[4] The ultimate strength values were taken as the unit load necessary to produce a deformation of 25% of the length of the specimen.

[5] These values are the average Brinell number of three impressions on each alloy using a 10 mm. ball and a 500 kg. load applied for 30 seconds.

reversed and the tin-base alloy had the lower friction loss. Comparison of the hardness values of these 2 metals at a temperature above 65° C. is not available but it appears that at this temperature the Bahn-metall would still be the harder of the two.

When the test bearings were run at elevated temperatures the tin-base one melted at 187° C., due to the presence of lead-tin eutectic, while the Bahn-metall bearing did not. At 233° C. the latter squeezed out but still did not melt. This appears to be a characteristic of all the alkali-alkaline-earth alloys. Although the alloys have high hardness values they also have good plasticity at ordinary temperatures. Bahn-metall, for example, can be compressed 28% without cracking.

Armbruster[22] found an alloy of the Bahn-metall type to be unsatisfactory at a load of 782 lbs./in.^{2} and the relatively high surface speed of 42.7 ft./sec. A tin-base alloy operated without difficulty under identical conditions. Similarly Fleischmann[24] found Bahn-metall to fail completely at 427 lbs./in.^{2} and a surface speed of 39.4 ft./sec. Bahn-metall, therefore, appears to be unsatisfactory for either heavy loads at low speed or moderate loads at high speed.

In a comprehensive comparison of lead and tin-base bearing metals, both in laboratory and service tests, Herschman and Basil,[23] did not find an alkaline earth hardened lead superior to the tin-base babbitts. Neither was it altogether inferior. In wear resistance the hardened lead was about the same as the other lead-base metals and lower than that of the tin-base. It exceeded both types in resistance to pounding at all temperatures. This is somewhat surprising in view of the tendency of these alloys to flow, although it is of course possible that flow does not occur, even in service, until the temperature exceeds 200° C. which was the limit in the tests referred to. Impact tests, while they showed hardened lead to occupy an intermediate position, indicated an increase in impact resistance with increasing temperature. This was just opposite to the results on the other alloys. This appears to be one of the factors that account for the high resistance to pounding, especially at elevated temperatures.

As would be expected from the discussion above, Herschman and Basil found the hardened lead alloy to have a higher Brinell number than either the tin or lead-base metals and this relationship was unchanged at 200° C. This is consistent with the compressive strength, based on 0.3% deformation, as the hardened lead was capable of resisting much greater stress at temperatures above 60° C. than any of the tin or lead-base alloys. Only one of the tin alloys was capable of carrying a higher stress at temperatures below 60° C.

In making service tests these alloys were used for main and connecting rod bearings in 2 truck engines. Here the hardened lead was found to wear faster than either the tin-base alloys or the other lead-base alloys. Dr. Kuknel advises that it has been the experience of the German State Railways that Bahn-metall is not as resistant to wear as the alloy WM80 which is used for axle and rod bearings on the locomotives. WM80 is a tin-base alloy with 12 Sb, 6 Cu, and 2 Pb. The English railroads have not adopted Bahn-metall.[25] They use one tin-base and one lead-base alloy of the following composition.

English Railroad Bearing Metals

	No. 1	No. 3
Antimony	10%	13%
Copper	5	..
Lead	..	75
Tin	85	12

The tin-base alloy is very similar to the German alloy WM80. The compositions of the best tin-base babbitt and the hardened lead used by Herschman and Basil are as follows:

Tin-base 4.6 Sb, 4.5 Cu, 90.9 Sn
Hardened lead 96.93 Pb, 0.18 Sn, 0.1 Cu, 0.33 Hg, 0.70 Ca and 1.70 Ba

Some doubt appears to be held concerning the effect of lubricants, especially those containing fatty acids, on all high lead bearing metals and the alkali-alkaline earth-lead alloys in particular. Some of the early alloys were deficient in this respect but there is not sufficient evidence to show that the alloys in service at present are significantly attacked by any of the common lubricants. In the rather extensive railroad tests with Satco referred to above there was no indication of corrosion. Special experiments were made to compare the effect of free fatty acids on Satco, genuine babbitt, and A.R.A. lining metal. There was no difference found between them. The limited tests on the Milwaukee Road with Satco did not show any definite signs of corrosion. It is perhaps worth while to point out that the reclaimed car oil used on the Milwaukee, contains about 1.5% of free fatty acid largely derived from the wool of the packing. This oil forms a large part of all the car oil used yet the oil does not contain any lead in solution after it has been in service for a year or more. The attack on A.R.A. lining metal by oil containing 1.5% acid evidently is not very extensive. Jakeman and Barr in their tests did not find any significant corrosion of their ordinary lead-base alloy by petroleum oils although there was some metal dissolved by olive and sperm oil which contained 1.1 and 1.4% fatty oil respectively. Bahn-metall was attacked 4 times as fast as the other lead-base bushings hardened with antimony and tin. The temperature of the oil and its rate of flow through a bearing probably are 2 significant factors in determining the rate of corrosion. For example when Satco is simply immersed in oil containing free fatty acids and heated to 300° F. the rate of attack is low. The formation of a protective coating of lead soap probably slows down the corrosion. When an actual bearing test is made with high load and speed and oil circulating rapidly, similar to service conditions in an automotive engine, the metal is attacked much more rapidly. In the case of railroad cars the temperature of the oil is low and circulation practically nonexistant. These differences in conditions of service appear to make a considerable difference in the usefulness of Satco in the presence of fatty acids.

Bierbaum[28] has recently suggested that some corrosion of the bearing by the lubricant is desirable and improves the bearing if the corrosive effect is limited to the softer constituents. Small channels which increase the amount of oil in the film may be produced. The capillary affinity of the oil for the metal surface may also be improved. Oleic acid has the virtue in dilute form of not attacking the hard crystals in the copper-tin bronzes, the lead and tin-base bearing metals, according to Bierbaum, but he does not mention the alkali-alkaline earth alloys specifically. Alloys in which the alkali or alkaline earth hardeners are all in solution can be expected to be more resistant to corrosion than others and probably the presence of compounds of the hardeners will also promote corrosion resistance.

Taking into account all the facts, it is evident that the original claims for the alkali-alkaline earth-lead alloys were a little too optimistic. These alloys will not carry as high loads nor function properly at as high speeds as will the best tin-base metals. They are, with the possible exception of Satco, subject to extensive loss of the hardening elements on remelting and consequently require special handling. But on the other hand they do have some unique and valuable properties. Their high compressive strength, hardness, and melting point are very desirable. These properties, coupled with the low coefficient of friction and satisfactory resistance to wear are conducive to long life and good service when the bearings are used under suitable conditions. The best field for them appears to be in those applications where a metal that is intermediate in properties between the tin and lead-base alloys is needed. The hardened leads cannot fill the need for alloys that will carry higher loads at greater speeds than the best white metal alloys in use at the present time. Since Satco is an improvement over Frary metal it is not unreasonable to expect further improvements will be forthcoming in this type of alloy. At least it is to be hoped that the metallurgists will justify the faith of the engineers by producing a bearing metal that will meet the demands of industry, whether it be of the hardened lead type or some other alloy.

Acknowledgment

The author desires to thank all of those who supplied material for this paper. In addition to those previously mentioned credit is also due to Messrs. J. Cartland and A. Mundey, London, Eng.; W. Stamer, London, Midland, and Scottish Railway; G. O. Hiers who furnished the micrograph for Fig. 6 and R. J. Shoemaker who furnished the photograph for Fig. 4.

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[30] R. J. Shoemaker. Discussion of above paper, pages 334-339.

[31] U. S. Patents 1,941,534 and 1,941,535.

[32] Frary & Temple. *Chemical & Metallurgical Engineering,* Vol. 19, 1918, page 523.

J. C. Redmond, a graduate of George Washington University, has joined the staff at Battelle Memorial Institute, Columbus, Ohio, and will be assistant analytical chemist. Mr. Redmond has been with the Bureau of Standards.

A recent addition to the country-wide organization of Toncan Iron distributors is Buhl Sons Co., Detroit, Mich., according to announcement by N. J. Clarke, Vice President in Charge of Sales, Republic Steel Corp., Youngstown, Ohio. Complete warehouse stocks of Republic's Toncan Iron will be maintained by the new distributor.

Production Tool & Supply Co.—B. J. Cahill, Secretary—has been appointed by the Hevi Duty Electric Company of Milwaukee, Wisconsin, as District Representative for the State of Missouri, with offices at 2832 Easton Avenue, St. Louis, Missouri. They will have charge of the Company's service and sales agency on electric heat treating furnaces.

Revere Copper & Brass, Inc., announce the opening of an office at 911 Rhodes-Haverty Bldg., Atlanta, Ga., in charge of Walter W. Fitts.

Editorial Comment

(Continued from page A19)

öperation of the A.S.T.M. and the A.F.A. which has previously brought forth the fine symposia on cast steel, cast iron and malleable, which so compactly and authoritatively set forth what the designer needs to know about the ranges of properties commercially available.

Newer materials were not neglected, 5% chromium and 5% chromium, ½% molybdenum still tube steels being particularly in the lime-light.

Those in attendance were truly grateful that the meeting was held at Atlantic City, with cool breezes off the ocean, at a time when there was a heat wave in the inland cities. The last couple of meetings that were held in Chicago were good imitations of Hades and we hate to remember that the policy of the A.S.T.M. now seems to be to hold alternate meetings at Atlantic City and in inland industrial centers, and, no matter where they are, to hold them the last of June. We hope the weather man has some pity in 1935 for the A.S.T.M. conventions, crowded as they are with committee activities as well as the technical sessions, grow wearisome when one has to mop the sweat from breakfast to midnight. The old-line custom of having the inland meetings happen to be in a very "hot spot" as the soil corrosion terminology goes, could well be abandoned.—H. W. GILLETT.

At a meeting of the Board of Directors of A. M. Byers Company on July 30th, **M. J. Czarniecki** was elected Vice President in charge of sales, succeeding H. W. Rinearson, resigned. Mr. Czarniecki was formerly General Manager of Sales.

J. E. Archer, a graduate in chemistry from Michigan State College, has been added to the staff of Battelle Memorial Institute of industrial and scientific research, Columbus. His assignment is electro-deposition problems, such as bearing alloys. Prior to his present position, Mr. Archer was four years associated with Prof. Colin G. Fink at Columbia University.

Jas. C. Vignos has joined the Sales Division of the Ohio Ferro-Alloys Corporation, Canton, Ohio, and has been assigned to the Eastern district. During the past eight years, he has devoted his efforts and time to the metallurgical and chemical field of the iron and steel industry, specializing in the production of alloys of iron and steel, high strength cast irons and special alloy irons.

Udylite Changes Name and Address

The name of the company has been changed from "Udylite Process Company" to "The Udylite Company"; and the general offices and laboratories are now located at 1651 East Grand Blvd., Detroit. Since the beginning of 1932, The Udylite Company has been actively engaged in the promotion and sale of a complete line of electroplating supplies and equipment in addition to the Udylite process of cadmium plating. From a small beginning in 1919, the growth of The Udylite Company has developed into an organization which spans the world. This steady growth has, at various times in Udylite's existence, made necessary the removal of offices and laboratories to larger and more suitable quarters. This latest move is the result of this continuous progress.

RHEOSTATS
ANODES

INTERNAL STRESSES

Part Four of a Correlated Abstract in Five Parts by Charles S. Barrett†

4. SHIFTING OF LINES

The most direct X-ray method for stress measurement is that employing the *shift* of diffraction lines in Hull-Debye-Scherrer photograms. It will be recalled that the position of a diffraction line is directly related to the spacing of the atomic reflecting planes by the Bragg law $n\lambda = 2d \sin \theta$ where θ is the angle of reflection, d the interplaner spacing, λ the wave-length of the beam, and n is an integer (the order of the reflection). When the interplaner distance is altered by elastic strain, the diffraction angle changes accordingly; if all of the reflecting grains are similarly stressed, the diffracted rays from all of them will superimpose to produce sharp lines displaced from their normal unstressed positions. The diffraction pattern then becomes a strain gage for disclosing macroscopic strains.

This idea was first applied to metallurgical problems by Lester and Aborn in 1925,[89] using the apparatus of Fig. 22. They used a thin steel ribbon specimen that could be loaded various known amounts in tension, a system of slits for directing a narrow beam of X-ray on the specimen, and a cylindrical film supported in a standard General Electric cassette behind the specimen. The X-ray beam penetrated the specimen (Mo Kα radiation of wave length 0.71 A. U. made this possible) and reflected from sets of atomic planes whose normals were approximately along the direction of the uniaxial stress.

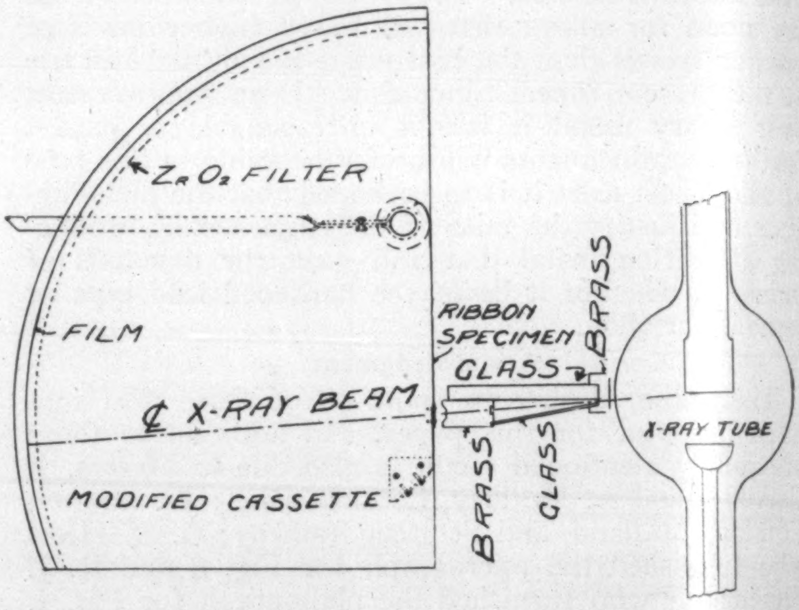
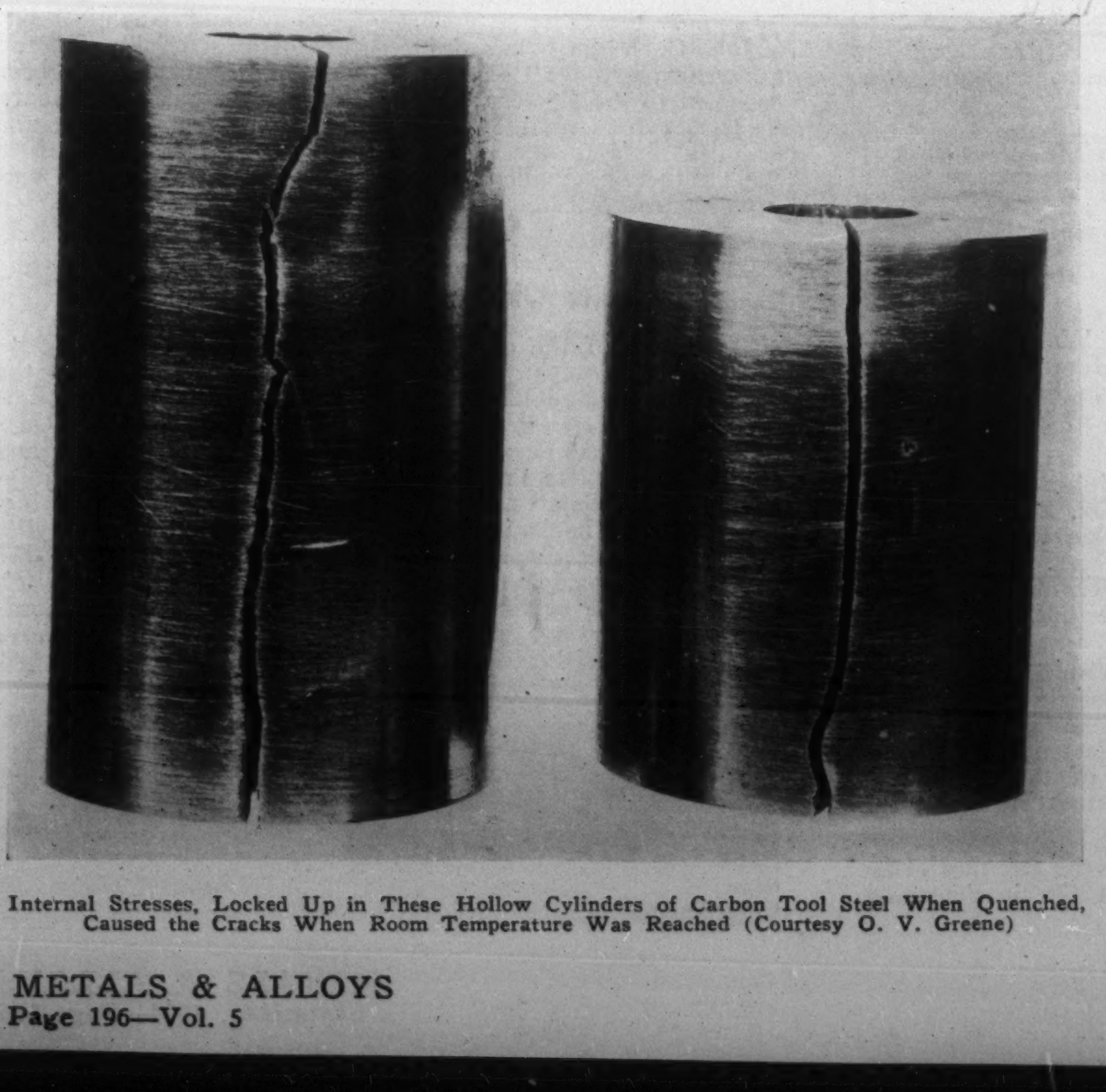


Fig. 22. Lester and Aborn's Apparatus for Strain Measurement by X-rays.

A typical curve obtained by them for interplaner distance vs. load is reproduced in Fig. 23, where it is placed beside a stress strain curve for the same material (the material was annealed high carbon shim stock, 1.13% C). The X-ray data shown in this figure are the average readings for six different diffraction lines. The figure shows a linear relation of interplanar distance to stress that was not evident in the readings of individual lines—possibly because of occasional strain recoveries accompanying the process of slip in individual grains. In the apparatus of Fig. 22, since the reflecting planes were approximately perpendicular to the direction of the applied stress, the change in spacing of the reflecting planes was ap-



Internal Stresses, Locked Up in These Hollow Cylinders of Carbon Tool Steel When Quenched, Caused the Cracks When Room Temperature Was Reached (Courtesy O. V. Greene)

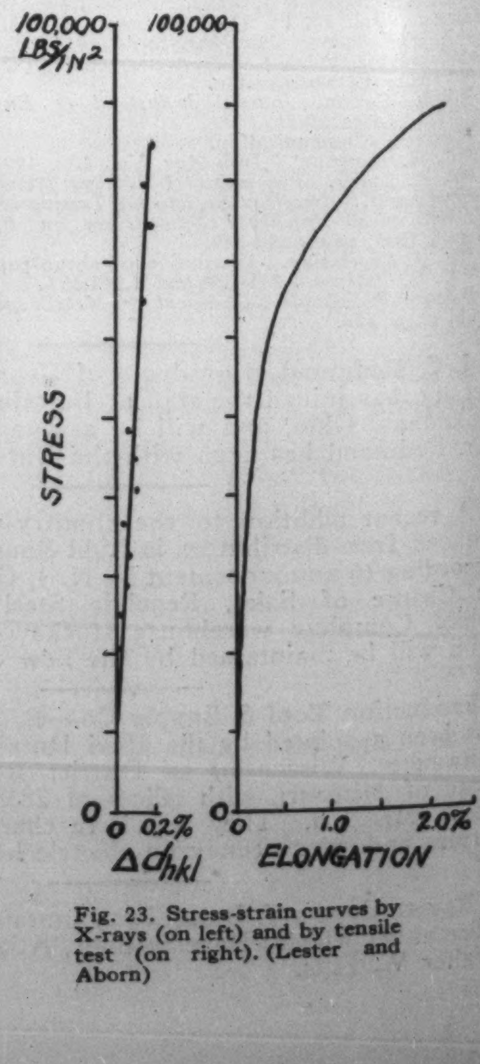


Fig. 23. Stress-strain curves by X-rays (on left) and by tensile test (on right). (Lester and Aborn)

proximately equal to the longitudinal strain in the steel ribbon.

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† Metals Research Laboratory, Carnegie Institute of Technology.

X-ray measurements of stress have recently been made in Germany using as reflecting planes not those perpendicular to the direction of the principal stress but those parallel to the surface of the specimen. This technique involves taking a photogram of the stressed metal in a back reflection camera of the general type shown in Fig. 17, with the X-ray beam falling perpendicularly upon the specimen surface and being diffracted back to a flat film.

The calculations for this case may be briefly summarized as follows:

Referred to rectangular coordinate axes, let the surface of a stressed metal contain the x and y axes, the z axis standing normal to it. If we assume the metal to be isotropic and to be subjected to a uniaxial tensional stress σ_x along the x axis, it will contract along the z axis an amount per unit length given by the relation $\epsilon_z = \frac{-\nu}{E}\sigma_x$ where ν is Poissons ratio and E is Young's modulus. The spacing between atomic planes lying perpendicular to the z direction will thereby be altered from d_o to d so that $\epsilon_z = \frac{d - d_o}{d_o}$. In practice it is not convenient to diffract from planes exactly perpendicular to z, so ϵ_z is not obtained directly from the diffraction photogram, but Sachs and Weerts have worked out the proper corrections to apply to reflections from other planes so as to obtain ϵ_z.[90] The procedure consists in calculating the average extension along the generators of a cone concentric with the z axis; this extension is then related to ϵ_z by means of an approximate formula for the ellipsoid of deformation.*

If a biaxial state of stress is assumed with principal stresses σ_x and σ_y along the x and y axes, the contraction along z will be $\epsilon_z = \frac{-\nu}{E}(\sigma_x + \sigma_y)$. The correction to be applied to reflections from planes not lying exactly normal to z varies with the ratio of σ_x to σ_y and hence cannot be applied when this is unknown. But Wever and Möller,[91] by sending an X-ray beam along the z axis and by limiting themselves to such high angle diffraction lines that the reflecting planes are nearly normal to z, have reduced the correction to a few percent so it may be neglected.

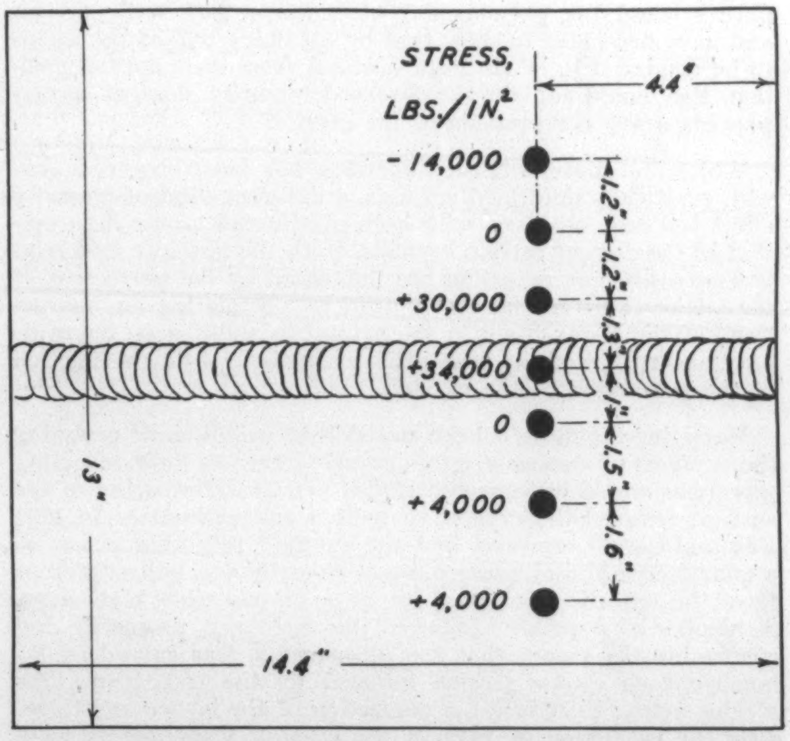
It will be seen from the above equation that the diffraction data give only the sum of the principal stresses in the plane of the surface, not the stresses individually, their ratio or their direction. An analysis of the biaxial case worked out recently by M. Gensamer and the author** gives equations for both the magnitude and direction of the two principal stresses, but requires for its successful application an accuracy in measuring diffraction lines that has not been attained thus far.

To measure stresses by the shifting of diffraction lines it is necessary not only to know the interplaner spacing, d, in the stressed condition but to know the unstressed spacing d_o. With externally applied loads this is readily obtained by removal of the load; with internally stressed material it requires annealing or some sort of drilling, slotting or sectioning of the specimen. The precision required in the diffraction measurements is very high, for an error of 0.0001 A. U. in interplanar spacing means an error of about 10,000 lbs./in.^{2}. The best accuracy has been obtained by the use of cobalt Kα radiation reflecting from the (310) plane of α–iron, and by copper Kα reflecting from (422) and (511) planes of duralumin, for these combinations give very large diffraction angles ($\theta = 82°$ for iron) and high sensitivity to strain. Early estimates[91] of the method put the maximum precision at about ± 7000 lbs./in.^{2} and later ones[92] at ± 1500 to ± 3000 lbs./in.^{2} in mild steel.

The radiation used in back reflection cameras is soft and penetrates less than 1/1000" below the surface of the specimen. Thus only the surface stresses are revealed in this type of experiment. There seems little possibility of developing a technique along these lines which can be used for the determination of internal stress distribution throughout a body; the chief obstacle is the fact that only surface stresses are revealed, coupled with the fact that a surface exposed by machining to a certain depth contains stresses which are not those originally present, but differ from them by an amount which is dependent upon the unknown stress distribution. This, of course, is a serious limitation to the practical value of the method, though it does not detract from its usefulness for determining stress distributions over the outer surface of a body.

Since a back reflection camera directs the X-ray beam to a spot on the specimen only 1/16" or 1/8" in diameter (at the most about 1/2") it is effectively a strain gauge with an exceptionally short gauge length. Because of this feature it should prove to be a very useful tool for studying stress concentrations near cracks, welds and riveted joints, and in general for surface stresses that are too inhomogeneous to be measured by the usual strain gauges.

The back reflection method as a means of determining average or total stress in a member—for example, the load on a beam in a bridge—must be used with caution. Here the stress distribution below the surface is of prime importance. Only when the stress is distributed uniformly or in a manner definitely known can the total load be calculated from X-ray measurements at the surface. If there are internal stresses of unknown magnitude superimposed upon the applied load, the method is of little value. However, a rough idea of the internal stress distribution can be had by making a series of X-ray measurements of both sides of a tensile specimen while loads are increased in steps until the yield point is reached, and then released, as has recently been done by Möller and Barbers.[91]



Internal Stresses at a Number of Spots on a Welded Steel Plate, Determined by the Back Reflection Method (Möller and Barbers)

An interesting outcome of the application of this method is the actual measurement in the surface of a steel strip of stresses far exceeding the normal yield point of the steel—in fact even exceeding the ultimate strength. Möller and Barbers[91] found the surface stress in an elastically bent steel strip to be twice the yield point, in one case. The supporting action of neighboring material that is less severely stressed is believed to account for this phenomenon.

Summary

The dimensions of crystal lattices in a body are altered by stresses in the same proportion as the external dimensions of the body. Precision measurements of these dimensions by means of the diffraction of monochromatic X-rays reveal the macroscopic stresses in the irradiated spot. Early experiments of Lester and Aborn using molybdenum radiation transmitted through a thin steel ribbon have been followed by methods in which long wave length X-rays are reflected back from the surface of a body, the reflected rays proceeding at large angles (nearly 180°) from the incident beam. The back reflection arrangement measures the sum of the principal stresses in the plane of the surface (since the penetration below the surface is slight, no stresses normal to the surface exist at the irradiated spot), and is capable of an accuracy of about 2000 to 5000 lbs./in.^{2} It does not disclose the distribution below the surface.

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*The analysis is a special case of a more general one by G. J. Aksenow, *Journal für Angewandte Physik*, Vol. 6, 1929, page 3016 (in Russian with German summary).

**As yet unpublished.

5. THE INTENSITY OF REFLECTION

The relative intensity of different orders of diffraction is affected by plastic deformation. For example, the ratio of the intensity of the second to the fourth order reflection from tungsten (100) planes increases from 8.35 ± 0.5 to 9.4 ± 0.4 when the annealed metal is cold rolled, according to measurements of Hengstenberg.[93] The ratio increases with the amount of cold work and decreases with annealing; in the example cited the ratio after annealing was 8.5 ± 0.5. This change in the ratio of low order to high order intensities varies from 10 to 60% in different metals.

The interpretation of this effect need not be discussed at length here* except to state that it is caused by changes in the electron distribution around the atoms and between atomic reflecting planes. Apparently the changes in electron distribution accompanying stresses within the elastic limit are negligible for no such effect on intensities has been found in this range; in the plastic range it is interesting to note, however, that metals such as aluminum which show no line widening when strain hardened (at room temperature) nevertheless do show this intensity effect.[65, 81, 96]

Masing, Dahl and Holm[95] have detected the distortion accompanying aging by this method. Hengstenberg and Mark[96] have studied the phenomenon with compressed KCl crystals and have been able to show that by assuming 3% of the atoms to be displaced 1/8 of an atom distance from their normal position, they could explain the observed intensity changes accompanying a 4% compression of the crystal.

While the above intensity decrease has been observed only with plastically deformed crystals, a different kind of intensity effect has been observed with both plastic and elastic deformation in the case of certain crystals. Both the absolute and relative intensities of reflection are influenced by the perfection of the lattice. This has been explained by postulating an "extinction" of the X-ray beam in the crystal in addition to the ordinary absorption of the beam, this extinction[97] being a function of the perfection of the crystal.

Many investigators[98] have noted that grinding or polishing the surfaces of various crystals greatly increases their reflecting power, as would be expected if this plastic deformation of the surface reduced the crystal perfection and extinction. In 1931 Fox and Carr[99] reported that the absolute reflecting power of a quartz crystal oscillating piezo-electrically was quite different from the reflecting power of the same crystal when stationary. A number of papers[100] followed this discovery, proposing and confirming the theory that the phenomenon was caused by inhomogeneous elastic strains induced by the oscillations, the strains acting to reduce the perfection of the lattice and to reduce the extinction of rays in the crystal. Experiments were made by Barrett and Howe[101] showing that the spots on a Laue photogram of an oscillating quartz crystal generally display a fine structure related to the mode of vibration of the crystal. They ascribed this fine structure to a variation of reflecting power from point to point within the crystal resulting from a complicated distribution of strains. Some Laue photograms of quartz under static inhomogeneous stresses substantiated this view.

There seems little likelihood that this second intensity effect will find any application to metallurgy, for it is only to be expected with crystals highly perfect in structure and with low absorption coefficients for X-rays, conditions difficult to attain in metal crystals.**

Summary

The relative intensity of diffraction in the different orders is altered by plastic deformation, even with metals that do not show strain widening of diffraction lines. Theory relates the effect to changes in the electron distribution in the deformed crystals. The absolute intensity of diffraction is altered by elastic stresses in quartz and other perfect crystals, but little, if any, in the less perfect metal crystals.

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Alfred V. deForest, widely known research engineer of Bridgeport, Conn., will join the staff of the Massachusetts Institute of Technology as associate professor of mechanical engineering in the fall. Mr. deForest's work will include study of the dynamic properties of metals, particularly the strength of full-size parts, and the relation between design, metallurgy, and application of load in modern machinery. The forces which produce and the factors that limit resonant vibrations will be an important part of the work, and he will give special attention to the development of new test methods and measuring instruments. His investigations are expected to lead to the establishment of a laboratory in which the knowledge and experience of the machine designer, the metallurgist and the physicist can be focussed on the working properties of machine materials. Mr. deForest graduated from the Massachusetts Institute of Technology in 1912. After leaving the Institute he was employed by the New London Ship and Engine Company for a year, following which he accepted appointment as instructor in engineering at Princeton University, where he remained until 1915. From 1916 to 1918 he was associate research engineer of the Union Metallic Cartridge Company, and from 1918 to 1928 he was research engineer of the American Chain Company. Since then he has been a consulting engineer specializing in the invention and application of various special test and inspection methods. Since the successful application in 1922 of a magnetic method of test for case-hardened chain, magnetic test methods were developed for the Fafnir Bearing Company and the New Departure Manufacturing Company. deForest has published a number of technical papers on magnetic methods of testing, and in 1928 the American Society for Testing Materials awarded him the Dudley medal for a paper on the subject. Since 1924 he has been secretary of the society's committee on magnetic analysis. The magnetic continuity test, invented by William E. Hoke, was improved by deForest. It has had valuable applications in the study and prevention of metal fatigue failures, particularly in the airplane field and in other cases where failure is particularly serious. In addition to investigations in magnetic analysis, deForest has long been interested in the fatigue of metals and has developed several test methods. The lack of elastic behavior of metals has also been a subject of study, resulting in a new type of precision spring scale.

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*Since this was written Komar and Obukhoff have published photograms that they believe show the effect in aluminum (*Physical Review,* Vol. 45, 1934, page 646). However, measurements of crystal imperfection in aluminum and other crystals by Bozorth and Haworth (*Physical Review,* Vol. 45, 1934, page 821) have shown that aluminum is one of the most imperfect of crystals, which implies absence of the effect.

** For summaries see A. H. Compton. X-rays and Electrons. D. Van Nostrand Co., Inc., New York, 1926; E. O. Wollan. *Reviews of Modern Physics,* Vol. 4, 1932, pages 205-257.

Specifications for Men

What Industry Expects Metallurgists to Know When They Graduate

A SURVEY

By Robert T. Ferguson Jr.*

THE TECHNICAL brain-power of the metallurgical industry is more vital to its continued development than the horse-power applied in its processes. Any firm insures itself with suitable stocks of ores and other raw materials, or assures itself that someone will always be able to supply them to its specifications, so that it can continue to do business. Were there no technical courses in universities, manufacturers would have to set up training schools of their own to insure a future supply of technical men.

Relying on the universities to supply the raw material from which metallurgists are later made in the plants, managers apply certain specifications for this raw material, as they do for inanimate raw materials. Who can say that the specifications for men are not even more important than those for materials?

This article represents an effort to correlate the specifications imposed by a very representative group of employers into one "Master Specification" of the technical knowledge that ought to be imparted in a course in metallurgy. Obviously of interest to the crop of young metallurgists now being raised and to the educators who are raising them, it will be of even greater interest to the executive who hires young technical men for the upbuilding of his organization in the years to come. Knowing what specifications are imposed by other employers who built their businesses upon the work of their technical employees, helps one to set his own specifications.

Grateful acknowledgement is made to the hundred outstanding employers of metallurgists whose replies to the questionnaire made this paper possible.

THE PURPOSE of this paper is to present a summary of the views of the country's leading employers of metallurgists on five questions of interest to employers, teachers and metallurgical students. The data used are based on the replies of 100 employers to the following questions:

1. What do you expect a newly hired metallurgist to know and to be able to do?
2. What college subjects are in your opinion most valuable?
3. What languages, if any, do you consider the metallurgist should become acquainted with?
4. To what extent do a man's college grades influence you in hiring him.
5. What abilities not directly connected with metallurgy—typing, bookkeeping, etc.—do you find most useful to the metallurgist?

This report deals specifically with what is expected of a newly-hired, relatively inexperienced graduate metallurgist and has nothing whatever to do with what is expected of experienced men. The discussion, representing the consolidated views of a large and representative group of employers, should be of considerable interest to those who plan college metallurgical courses.

Metallurgists have been classified into two groups: 1. Industrial metallurgists, and 2. research metallurgists. This classification has been found desirable because the replies definitely indicate that industry itself, consciously or unconsciously, makes this classification in hiring men. Most metallurgists may be classified into one of these two groups.

By industrial metallurgists is meant those whose work consists primarily in applying metallurgical information to some stage of metal processing, whether in the capacity of owner, supervisor, or workman. Such a metallurgist may supervise the extraction of metals from ores, work in a laboratory making routine physical or chemical tests, supervise treatment and fabrication of metals, and so on; but whatever he does he will be primarily applying his knowledge to some stage of the preparation of metal for actual use.

By research metallurgists is meant those whose work is essentially creative, such as developing a new process or a new alloy, and those whose work is connected only indirectly with some phase of processing metal for the finished product, such as developing or improving fluxes or developing new protective coatings. A man may, of course, work in both capacities at the same time.

What do you expect a newly hired metallurgist to know and to be able to do?

The replies of 93 representative employers are tabulated in Table 1; a study of this tabulation should give the student metallurgist considerable insight as to what employers want, and hence give him an idea of what he must know and be able to do if he wants a job as a metallurgist.

General Expectations

Employers commonly expect a newly hired graduate metallurgist to thoroughly know and be able to apply the fundamental principles of three subjects: 1. Metallurgy with all its ramifications including metallography and physical testing; 2. chemistry including routine analysis and physical chemistry; and 3. physics as it applies to metallurgy. These are the basic courses of metallurgy.

TABLE I. What the newly hired metallurgist is expected to know and to be able to do.

Number Answering Question: 93

Fundamentals of metallurgy (particularly physical)	48	51.6%
Fundamentals of chemistry	42	45.2%
Metallography	37	39.8%
Fundamentals of physics	29	31.2%
Routine physical testing	24	25.8%
Routine chemical analysis	18	19.4%
How to recognize, analyze, and tackle problems	18	19.4%
Heat treatment	17	18.3%
Mathematics	16	17.2%
How to get along and work with others	13	14.0%
Good laboratory technique	13	14.0%
Physical chemistry	12	12.9%
How to use reference books (keep up to date)	12	12.9%
How to follow instructions specifically	10	10.8%
How to write worthwhile reports	10	10.8%
Metallurgical procedures (alloying, casting, etc.)	10	10.8%
How to make and use laboratory equipment	9	9.68%
Mechanical engineering	6	6.45%
Electricity	5	5.37%
Geology, mineralogy, crystallography	5	5.37%
How to adapt himself	4	4.30%
Pyrometry	4	4.30%
Drawing	3	3.23%
Materials	3	3.23%
How to recognize and associate facts	2	2.15%
History of metallurgical processes	2	2.15%

In addition, the new man is expected to have certain practical knowledge without which, most employers agreed, the man has little chance of achieving much success as a metallurgist. He must: know how to recognize, analyze, and tackle the problems which arise daily; know how to follow directions oral or written; have developed a good laboratory technique; be able to use reference books to educate himself along

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special lines and to use current literature to keep up to date on events of interest to his company; be able to adapt himself rapidly to his new environment; and be able to think logically and work hard.

Expressed in the words of one eminent employer: "A young metallurgist should above all be familiar with the principles of metallurgy and those branches of physics and chemistry which enter most into metallurgy—for instance he should have a thorough understanding of all the simpler types of equilibrium diagrams, and he should have the capability of observing accurately and of developing experimental skill." Employers usually expect a man upon graduation to have a sound *theoretical* training for his work as a metallurgist; but in general they do not ask him to have much practical experience, for the simple reason that he can't ordinarily get it before he graduates. For this reason, the new man generally enters upon what might be called an apprenticeship in which he is trained in various operations by an experienced man. Several companies estimate that at least six months of such training is necessary before a graduate can be expected to work on his own initiative. Of course if the graduate does have practical experience, he is expected to be able to do much more than indicated in this report.

The Industrial Metallurgist

Generally a newly hired metallurgist who gets work in an industrial plant begins his apprenticeship with some kind of routine control or check-up work in the plant laboratory. This may consist of routine qualitative or quantitative analysis of common ores or metals, work in metallography, or physical testing of materials. In small laboratories he may be called upon to do all three. It is assumed, therefore, that he will have developed some degree of skill in these routine laboratory procedures by the time he graduates, and that he will be able to adapt himself to the practices of the particular plant without too much watching and coaching.

If he does analytical work, he is not expected to know the details of commercial methods of analysis, but he is expected to have developed sufficient laboratory technique to follow oral or written methods easily and to obtain results accurately and rapidly, and to understand the reason for each step taken, since he will have to use the methods of the plant rather than his own.

Metallographic work may at first consist mainly of preparing metallographic specimens; it is expected that the recently graduated metallurgist will be able to prepare satisfactorily both ferrous and non-ferrous specimens. Some employers also expect him to examine these specimens by the metallurgical microscope, to take photomicrographs and to be able to interpret the structures.

It is expected that he is familiar with the physical properties of the common metals. This is particularly important in fabricating industries. He should know the usual method of finding such commonly determined physical properties as tensile strength, elastic limit, hardness, fatigue resistance, modulus of elasticity, and impact.

As he grows accustomed to working in the plant and begins to establish his worth, he is given assignments of greater responsibility which require additional knowledge. In ore-dressing plants, for instance, he is expected to have a general knowledge of the principal operations of smelting and refining of common metals, both ferrous and non-ferrous, so that he can prepare furnace charge sheets, check up on operations when something is wrong, supervise rebuilding of furnaces, etc. This may require knowledge of fluxing, heat balance, furnace design and construction, and the principles of pyrometallurgy and electrochemistry. In fabricating plants he is expected to have a knowledge of commercial heat-treating methods and in some cases is expected to be able to recommend and supervise heat treatments for carbon steels or other well-known alloys. One employer said, "I expect him to know the constitution diagram of iron-carbon alloys so that he could draw it in his sleep." For such work he must be well grounded in the principles of physical chemistry, alloying, and commercial pyrometry. The better he knows and can apply these principles, the higher will be his pay and the more rapid will be his promotion to positions of responsiblity.

These are the more specific qualifications which a metallurgist must have in order to get a job; many employers warned, however, that it is not enough that the graduate industrial metallurgist have simply this knowledge in order to succeed. For his own good and for the good of the company, they hope he knows a number of less specific things which are more difficult to measure or determine in an interview but upon which his ultimate success largely depends.

A number of employers emphasized that an industrial metallurgist should have a rather thorough grounding in many other engineering subjects, such as mechanics, because he will constantly find use for such knowledge. He needs, for example, as much familiarity with shop practice as he can get, and he finds skill in drawing and design useful. Subjects which help him comprehend his part in industry, such as economics, psychology, and business methods, are of great ultimate value to him. Ability to control his temper, even under the most trying conditions, is considered a distinct asset and so is the ability to work harmoniously with others including the more or less illiterate workman. Probably the greatest asset an industrial metallurgist can possess is that of leadership—that quality which will make him get along pleasantly in his surroundings but still leave him able to influence his fellow workers. Such abilities are not taught in school, but they can be developed.

The Research Metallurgist

The training, work, ability, and background expected of the research metallurgist by employers are quite different from the demands made upon the industrial metallurgist. Research metallurgists frequently *start* doing the same sort of routine testing that industrial metallurgists do, and consequently the man who expects to get a job as a research metallurgist must also be fairly proficient in routine chemical analysis, metallography, and physical testing. Aside from this, however, the work is different.

As soon as the research metallurgist proves his value, he is set to work on a problem, under the guidance of an older man. He will be told what to attack, when to shift his method of attack, when to drop the problem and go on to another, etc., but "he will be expected to stand on his own feet and use his ingenuity for considerable periods between conferences." For this reason, he must be able to be his own efficient boss, a thing new to most college men. He must have ability to anaylze his problem to determine what really needs to be done. Such ability comes only with experience and hence any experience he can get in college working on such problems under competent direction will be invaluable to him. He must know where and how to get necessary information quickly and easily; this means among other things that the research man must know how to use the library and the literature. Because he may have to build his own equipment, any experience he may have with design, glass working, shop work, forging, welding, etc., will be helpful to him.

To do his work efficiently, the training of the research man must be at once broad and intensive. He needs a very thorough training in metallurgy, chemistry, physics, and experimentation and to a lesser degree in mathematics and other engineering subjects. Employers expect him to be entirely familiar with the use of all the tools of the metallurgical profession, such as the microscope, X-ray diffraction equipment, methods of determining constitution diagrams, and methods of measuring high temperatures.

He should be a close observer and keep intelligent and accurate records of his procedure, observations, and data. He should have a natural curiosity as to the cause of any result which is not in accord with what he expected. He is expected to be absolutely impartial with the results; that is, never see or report anything that he or his superiors would like to see or have reported unless the experimental facts themselves make him see it. He should follow instructions meticulously, but should tactfully and respectfully make suggestions for the betterment of the program or the product if careful consideration leads him to believe that such suggestions are sound.

It is desirable that he be familiar not only with present-day metallurgy but also with historical metallurgy, because such knowledge gives the investigator a large stock of knowledge with which to guide himself in development work.

He is expected to have a thorough knowledge of good, simple English composition and report writing. This is very important. His work calls for frequent reports, often detailed in nature, and for the writing of papers covering investigations, etc.; consequently, the ability to express his findings in a clear, logical, and concise report or letter is valuable, particularly since it is not common among metallurgists, many of whom are "deplorably weak in English." The manager of a large research laboratory emphasized this point: "I would say that English is the most important single subject for the success of an able metallurgist. In fact, I would not put it second to any other subject if the man expects to go far in research and development work. I believe that the ability to express himself acceptably is more important to the research metallurgist than any other single subject, even including mathematics, chemistry and physics."

The ability to get along with the average workman is of importance to the research metallurgist, because even though his work is commonly done either alone or with those in his own particular line of work the time will surely come when he will have to make some process developed in the laboratory prove its worth in the plant.

What college subjects are in your opinion most valuable?

This question deals specifically with the value of college subjects—a thing which is not necessarily covered by the first question. For example, the practicing metallurgist might consider mechanical engineering a very valuable subject, and yet might not expect a newly hired metallurgist to know very much about it. The purpose of asking this question was to determine what particular college subjects were considered most worth while in order to give the student and the teacher a better idea of what to study and to teach.

It must be understood that although chemistry, physics, and mathematics are considered most valuable, they would be worth little unless supplemented by a number of other subjects, such as metallography and English, which rank lower in Table II. In other words, while certain subjects deserve special attention in a well rounded curriculum, it would be folly to concentrate entirely on them.

To tabulate the replies to this question as fairly and impartially as possible, it was necessary to determine, in some measure at least, the value placed on each subject in each reply; i.e., to weigh the replies. Further, because many of the replies seemed to divide the subjects mentioned into two groups—those of primary and those of secondary importance, with subdivisions of first, second and third rank—it was necessary to attempt to classify all the replies in this manner. Thus if an answer said "physics, chemistry, and mathematics," then physics was given first rank, chemistry second, etc. Undoubtedly many who answered this question did not intend to list the subjects in order of importance, but the ultimate result of classifying a great number of replies in this manner seems to give a fairly accurate and logical picture of the value metallurgists place on the various subjects.

The subjects which employers of metallurgists considered fundamentally important are: chemistry in general, physics, mathematics, metallurgy, physical chemistry, metallography, English including report writing, analytical chemistry, mechanical engineering, human relationships or some kind of psychology, drafting and design, and thermodynamics. Each of these was considered most important of all by at least one employer. "Chemistry in general" should by all means include analytical chemistry and physical chemistry, and might well include such subjects as electro-chemistry, colloid chemistry, and chemical-thermodynamics. "Mathematics" should always run through trigonometry and the replies generally indicated that it should extend through calculus; a few felt that hydraulics should be included. These courses might well form the nucleus about which a metallurgical education should be built.

The subjects of secondary importance may be found in Table II. None of these subjects was rated fundamentally important by employers, but each has proved worth while. Supplementary subjects which would be useful to the particular type of work the metallurgist is interested in might well be picked from this group.

TABLE II. Subjects considered most important for a metallurgist in the opinion of metallurgical employers

Number Answering Question: 84

PRIMARY

	First	Second	Third	Total	% Total
Chemistry, in general......	32	23	7	62	73.8
Physics	23	26	7	56	66.7
Metallurgy	21	10	17	48	57.1
Physical chemistry	17	13	4	34	40.5
Mathematics (Trig. & Calc.)	13	16	23	52	61.9
Metallography	7	6	9	22	26.2
English (incl. reports)......	6	4	5	15	17.9
Analytical chemistry	3	4	2	9	10.7
Mechanical engineering	2	4	12	18	21.4
Human relationships	1	2	2	5	5.95
Drafting and design	2	5	5	12	14.3
Thermodynamics	1	4	1	6	7.15

SECONDARY

Geology, mineralogy, crystallography	8
Mechanical and testing laboratory	6
Economics	2
Electricity (electrical engineering)	9
Shop work	5
Pyrometry	4
Cultural subjects	4
Public speaking	3
Heat treatment	2
Precision of measurements	2
Gas analysis	2
Business administration	2
Commercial law	2
X-ray (including radiography)	2
Corrosion of metals	1
Electrochemistry	1
Foundry and forge	1
Mining	1

Examination of Table II will reveal that, by and large, the metallurgical curricula of most colleges require most of the primary subjects and embody a choice of most of the secondary subjects. This fact was brought out by several men who stated specifically that they considered those subjects contained in the ordinary metallurgical curriculum as most important.

What subjects, then, should a well rounded college metallurgical course contain? There can be no fixed answer to this question, but in general, in the opinion of a large number of practicing metallurgists, it should certainly involve time spent first, on the twelve primary subjects as a nucleus and, next, on those secondary subjects which will educate the metallurgist along the line of work he is most interested in. Finally any time left should be spent on the more cultural subjects, because such interests prove valuable, metallurgists say, in later years as broadening agents, refuges, safety valves, and sources of constructive pleasure.

What languages, if any, do you consider the metallurgist should become acquainted with?

This question unfortunately proved somewhat ambiguous inasmuch as it neither specifically included nor excluded the English language. It was originally intended that only foreign languages would be included under this question, but so many valuable replies included English that it was included in the tabulation. This ambiguity must not be overlooked when studying Table III in which the replies to this question are tabulated, since English would unquestionably rank far higher had the replies uniformly included it.

The reason for asking this question was to determine whether practical experience shows that the metallurgical student should or should not become acquainted with foreign languages; and, if he should, to determine what languages are best and to what extent they must be learned.

The results tabulated in Table III confirm the general impression that if the metallurgist can read one foreign language, that language should be German. French comes sec-

TABLE III. Languages considered most important

Number Answering Question: 95

	Essential		Quite desirable		Total	
	No.	%	No.	%	No.	%
English (reports)	30	31.6	2	2.1	32	33.7
German	44	46.3	44	46.3	88	92.6
French	14	14.7	40	42.1	54	56.9
Latin	4	4.2	4	4.2	..	...
Spanish	..	...	9	...	..	...
Italian	..	...	2	...	..	...
Swedish	..	...	2	...	..	...
Russian	..	...	1	...	..	...
Japanese	..	...	1	...	..	...

ond, but is certainly less important that German, which some employers consider more important than all other foreign languages combined. 46.3% of those answering this question considered a good reading knowledge of technical German practically essential to the success of a metallurgist; and 46.3% more considered it quite desirable. Consequently, since 92.6% of a representative group of employers considered German quite desirable, there seems to be little doubt that German should be in the curriculum of student metallurgists. On no other point was there such unanimous agreement. 15% considered French essential, 42% considered it desirable.

In general, industrial metallurgists place far less value on foreign languages than do research metallurgists. Industrial men were more inclined to rate Spanish above other languages, claiming that there is considerable opportunity in Central and South America for the metallurgist and consequently that he should learn to speak and write Spanish if he has the opportunity. The six replies stating that foreign languages were unnecessary came mainly from industrial metallurgists in fabricating industries in which this country is the recognized leader. Quite naturally they do not consider foreign languages of great importance. They said that in their particular fields at least excellent translations are usually available and that the amount of training which the student gets in foreign languages in college is so inadequate and that it is cheaper for them to have a particularly interesting article sent to a technical translator who can translate it accurately.

But while foreign languages are not considered especially helpful to the industrial metallurgist, German and French are considered of paramount importance to the research metallurgist, because an enormous volume of material is available in German and French literature and patents. "A reading knowledge of technical German is essential for the research man," was a typical statement. Note that *technical* German is needed, not "a lot of classical German of the type ordinarily taught." The man who can study works published in English, German, and French can cover a wide range of scientific data. Such a man, other things being equal as they well may be, has a very much greater chance of going far in development work than one not so equipped. A knowledge of Russian, Japanese, Swedish, and occasionally Spanish and Italian would be useful to him if local or special conditions made it possible for him to learn them.

While it is expected that the research metallurgist will at least be able to read technical German quite readily, it is the opinion of many that unfortunately his ordinary college training in languages leaves him unprepared to do this. It has therefore been suggested that the student study German or French grammar in college and then build up a technical vocabulary *himself* by reading and re-reading technical articles on subjects of interest.

The results therefore show that the industrial metallurgist generally does not need foreign languages, but that the research metallurgist should at least have a good reading knowledge of technical German. German is *the* foreign language for the metallurgist; French is important but ranks considerably below German; Spanish is a very weak third.

To what extent do a man's college grades influence you in hiring him?

Students are constantly wondering: "Of what value are college grades?" For the most part this question remains unanswered till too late.

TABLE IV. Influence of grades when hiring a man

Number Answering Question: 98

Slight influence (may not even investigate)	43	43.8%
Some influence, when with other things	29	29.6
Some influence alone	3	3.6
Considerable influence with other things	10	10.2
Considerable influence alone	13	13.3

The answers to this question were tabulated under five heads ranging from those employers who said they were considerably influenced by grades to those who said grades influenced them very little. Good arguments were given substantiating each view. The results show that in hiring a man, only about one employer out of eight (13.3%) is willing to hire on the strength of grades alone, and only about one in ten (10.2%) thinks grades very important even when considered with the other qualifications of an applicant. 30% of the employers indicated that grades have some influence when considered in connection with other characteristics, but almost one half of them said they were influenced only very slightly or not at all by a man's grades.

Probably the reason why so many employers fall into this last group is that too many other factors—such as initiative, mental attitude, executive ability, personality, the likelihood of having a well-balanced intellect, the amount of commonsense, and general reports as to character and ability—are of much greater importance. Furthermore, many employers have little faith in grades, as is illustrated by this reply from the general manager of a large Eastern corporation: "I never inquire into a man's college grades. Matriculation from a recognized school is sufficient guarantee that a foundation has been laid that has passed competent inspection." Others went even further to say: "My experience with a great number of men over a range of years has been that men making best grades in school are more frequently not the best men in the field; and it is not only possible but probable and happens with a degree of regularity that very poor students are the most valuable when employed."

Nevertheless, grades are considered so important to some industrial employers that they may be the determining factor as to whether a man is hired or not. Some rarely hire a man whose grades in scientific subjects did not put him in the best 25 or 30% of his class; but even these may also lay stress upon his ability, personality, etc. "While a man is in college," said one employer, "doing the work assigned to him is his job and how well he does it seems to be a fairly good index of how well he does any job. We doubt whether many men with adequate ability for technical work cannot, by reasonable application, place in the first quarter of the average college class." Consequently a number of employers said that "It has no mean effect when an applicant can say that he is of top 10% in grades."

College grades generally influence all employers of research metallurgists. The degree of this influence ranges from "some" to "considerable." The particular influence of grades for the research man is illustrated by this statement: "College grades influence us less than a man's appearance and personality, unless he is to go into the Research Department, in which case his college record, that is grades, would influence us to a great degree." The director of a large fabricating organization justified this view saying, "It has been our experience that outstanding students are usually the most intelligent and justify their selection by subsequent performance."

"Other factors" enter into the hiring of research metallurgists just as they do in the case of industrial metallurgists, but are not ordinarily so highly stressed. The recommendations of a student's professors, however, are usually given considerable weight. "I consider it a recommendation for a man," said one typical employer, "to have made good grades, and particularly if they are such as to impress his teachers enough to recommend him as being especially capable."

The conclusion to be drawn from this information is probably that college grades of an applicant ordinarily have little influence one way or another in the hiring of most industrial metallurgists; but occasionally good grades are considered a recommendation, and only in rare instances are they considered harmful. On the other hand, a research metallurgist will stand a much better chance of getting work if he can say that he is at least in the upper quarter of his class.

What abilties not directly connected with metallurgy—typing, bookkeeping, etc.—do you find most useful to the metallurgist?

It is generally agreed that the successful metallurgist must know certain things only remotely connected with the profession. To ascertain what talent has been most useful was the purpose of asking this question. Typing and bookkeeping were used merely as examples, but this very suggestion probably resulted in an undue emphasis upon them in the answers. The results, nevertheless, should give the student an idea of what unrelated subjects are considered valuable.

The extra abilities most frequently listed included typing, the ability to write reports, cost accounting and analysis, shorthand, bookkeeping, ability to think and speak clearly, ability to keep good notes, knowledge of business, ability to get along and initiative. There was, however, no unanimous agreement on their value.

"The abilities not directly connected with metallurgy which are most useful to the research metallurgist are (a) the ability to build his own experimental apparatus, which now-a-days means ability to handle welding and cutting torches, to burn lead, blow glass, use wood and metal working shop machinery, etc., and (b) to do his own typing, not only to save time in drafting reports and papers but to obtain greater neatness and legibility, and (c) ability to write clearly and with correct English. A research metallurgist is always writing notes, reports, professional papers, and sometimes books. Most professional men seem to abhor English classes while at college and miss an excellent training that they might obtain."

TABLE V. **Abilities not directly connected with metallurgy**

Number Answering Question: 78

Typing	32
Ability to write reports	22
Cost accounting and analysis	13
Shorthand	10
Bookkeeping	10
Ability to keep good notes	8
Ability to speak and think clearly	8
Knowledge of business	7
Ability to get along	6
Initiative (driving energy)	6
Mechanical engineering	6
Participation in school activities	5
Economics	4
All around ability to handle problems	3
Personality	3
Cultural subjects	3
Electrical engineering	3
Organic chemistry	2
Ability to analyze results	2
Neat hand-writing	2
Commercial and patent law	2
Lubrication and fuels	1
Ability to live in small towns	1
Tact	1
Drawing	1
Civil engineering	1
Salesmanship	1
Public speaking	1

Typing is usually considered worth while because it makes possible the keeping of clear, accurate and comprehensive reports, correct, data, etc., when no regular stenographer is available. The ability to write good reports and to use the English language was again strongly advocated here. Several employers felt it "decidedly advantageous" for the metallurgist to possess some knowledge of cost accounting and others considered shorthand as much worthwhile as any subject not directly connected with technical training.

The ability to make professional friends is very important and is a very important tool in the hands of a would-be metallurgist. "A good training for the young metallurgist," said a president of a well known company, "is the attending of meetings of various organizations in his special field. At these meetings he rubs shoulders with practical and successful business men, engineers, mechanics, etc., and if he is able to absorb what he hears not only from the speaker but from older and experienced men that he comes in contact with at these meetings, he will develop much faster and gain practical education much quicker." At such meetings he gets acquainted with men who are interested in the same things that he is; he makes friendships and establishes contacts which may prove invaluable to him. For the metallurgist his professional friendships are of paramount importance to his progress, and the ability to make these contacts is considered very important for the young metallurgist.

Conclusion

Newly hired metallurgists are expected to know and to be able to apply the fundamental principles of metallurgy, chemistry, and physics first of all; they should be able to do analytical work, metallographic work, and physical testing from the start. Generally speaking, the industrial metallurgist uses very little of the mathematics he has learned, and applies only elementary physics and chemistry; the big things for him to know are practical metallurgical shop technology and how to deal with, control, and get along with workmen. Foreign languages are of minor value to him unless he is to work in a foreign land. College grades have little influence in the selection of such a man, although occasionally an employer is considerably influenced by an applicant's grades. Equally important to grades, in the opinion of most of this type of employer, is success in extra-curricular activities where leadership and the ability to handle people are developed. Frequently the opinion of a man's professors is given considerable weight. Auxiliary engineering subjects, particularly mechanical, are very useful to him.

The research man needs a broad as well as intensive metallurgical background, and has to be able to educate himself, to be his own boss, to think clearly, analyze, observe, carry out, and draw logical conclusions, and to convey his findings orally or in writing to others. German and French are important to him. Scholastic achievement—that is grades—is quite commonly used as a measure of his ability to do research work when he applies for a job. Practically any auxiliary training, especially English composition for report writing, will be most helpful to him.

First All Stainless Plane Returned to U. S.

The first all steel airplane ever built, a four-place amphibian, is back in the United States after two years exhibition in Europe. The plane, property of the Edward G. Budd Manufacturing Company, of Philadelphia, was built 3 years ago to demonstrate the practicability of the shot-weld process of fabricating stainless steel.

After a flight around the United States it was sent to Europe where it aroused the interest of the navies of several countries. Arriving in Italy it was flown from Genoa to Rome where it was demonstrated to Mussolini. From there it went to various Italian naval bases for study by naval engineers. As a result stainless steel was used in parts of the ship which Balbo flew to the United States at the head of a fleet of Italian planes last summer.

From Italy the plane was flown across the Alps to France where it was demonstrated to leading aircraft manufacturers and military and naval authorities. On several flights it was piloted by Gene Assolant, who won fame for his trans-Atlantic flight in the Yellow Bird.

Assolant flew it across the channel to England where it was demonstrated for the Royal Air Force. From England it was flown back to Italy, through Holland and Belgium, and has been in the service of the Savoia-Marchetti Company which has been licensed to manufacture the plane in Italy.

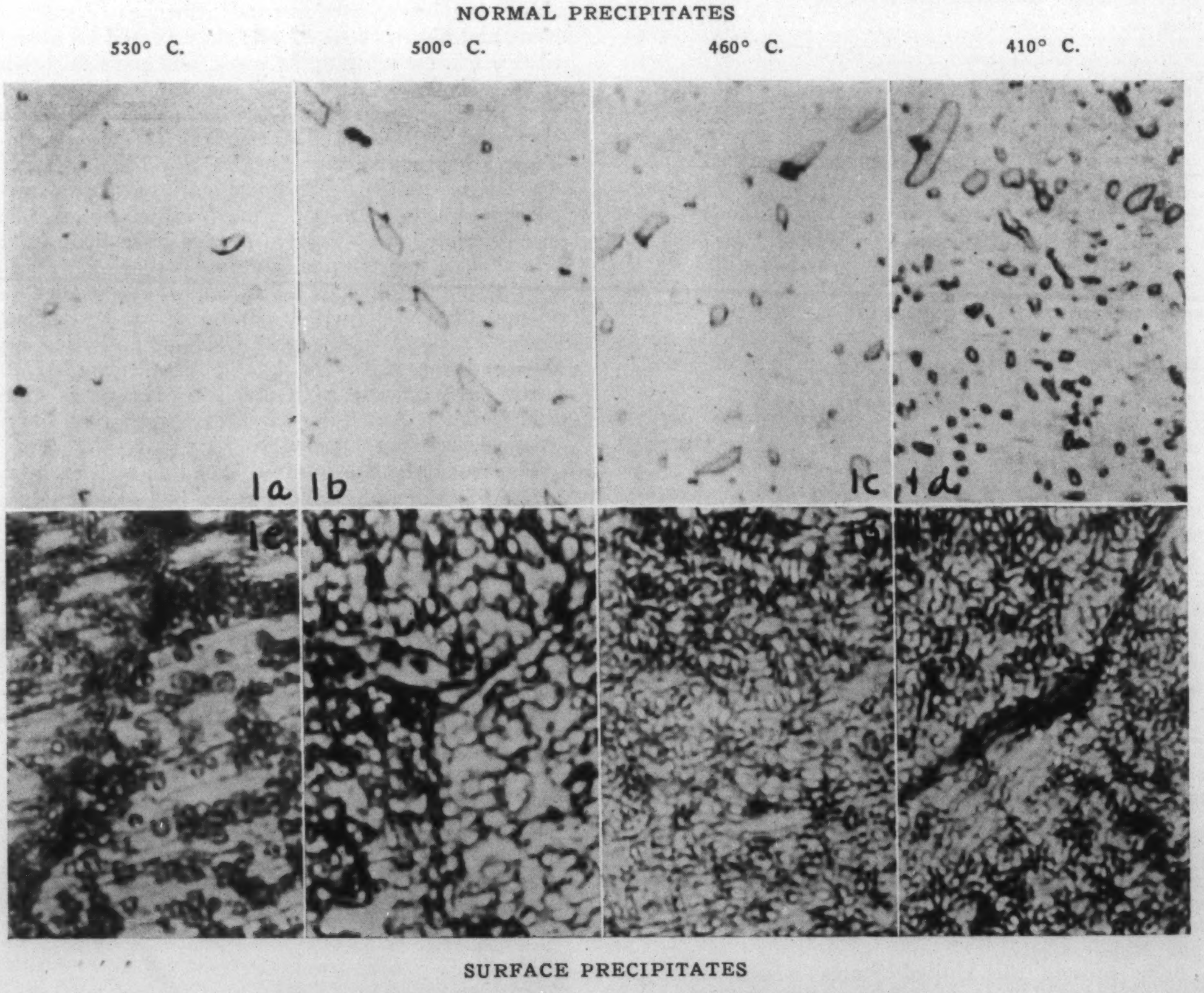
Upon its return to the United States, the plane was turned over to Fleetwings, Inc., Roosevelt Field, licensee of the Budd Company. Besides the Savoia-Marchetti Company, the Potez Airplane Company, of France, and the Pressed Steel Company, of England, have been licensed to build the plane in their respective countries. The Savoia-Marchetti Company has received a number of orders which are now in production.

THE EFFECT OF

Surface Strain On Solid Solubility

Arthur Phillips* and R. M. Brick†

THE EFFECT of polishing operations on the structural condition of metal surfaces has been of theoretical interest since Beilby,[1] some 25 years ago, made the observations which led to the conception of the amorphous metal hypothesis. Renewed interest in the nature of the altered surface film has been recently stimulated by the development of electron diffraction methods,[2] which seem to be particularly adapted for the study of thin sections. Although several workers have been actively engaged in this line of experimentation, it cannot be said that the structural effects of polishing are firmly established. G. P. Thompson,[3] using electron diffraction methods, concluded that the film consists of amorphous metal and R. C. French[4] using a Thompson electron camera reported that a new but semi-orderly arrangement of atoms predominate. Theoretical considerations[5, 6] seem to indicate that the atomic planes in the surface layers, or in very minute crystals, have spacings differing by several percent from those of the undeformed metal. On this assumption, J. T. Randall and H. P. Rooksby[7] interpreted French's results somewhat differently, claiming that the surface layer is essentially crystalline. F. Kirchner[8] also disagreed with French's analysis. He postulated that unpolished surfaces have lumps or fins sufficiently thin for the passage of electrons, thereby acting as a grating to yield sharp diffraction lines. If, however, the fins are removed by careful polishing, the lines denoting a crystalline structure are at least partially eliminated. C. A. Murison, N. Stuart, and G. P. Thompson[9] later presented evidence of the disappearance of diffraction lines in cases unexplainable by Kirchner's hypothesis. W. Boas and E. Schmid,[10] employing X-ray methods, reported an external crystalline layer approximately 0.02 mm. in depth with an underlying intermediate layer of deformed metal perhaps 10 times as thick. It has been suggested by L. Hamburger[11] that the assumption of minute crystalline fragments of from 3 to 30 atoms on the surface would reconcile the divergent viewpoints. L. H. Germer[12] on the basis of electron diffraction studies on drawn wires and polished surfaces, offered evidence against the amorphous layer theory. Wire drawn through a good die gave general scattering but no diffraction lines. On the other hand, wire drawn through a cracked die gave complete Debye-Scherrer circles which indicated, according to Germer, that the highly worked yet crystalline metal fins had diffracted electrons. Germer attributed his failure to obtain a pattern for the good die, or from polished surfaces, to line broadening and overlapping. Finally, French[13] after further work reiterated his belief in the formation of a highly disorganized atomic structure, substantially amorphous in character.


NORMAL PRECIPITATES

530° C.

500° C.

460° C.

410° C.

SURFACE PRECIPITATES

Fig. 1. Specimens Heat Treated 5 Hours at Indicated Temperatures.

In spite of the many studies dealing with the nature of polished surfaces, it is obvious that we have not progressed much beyond the speculative stage in our efforts to visualize the

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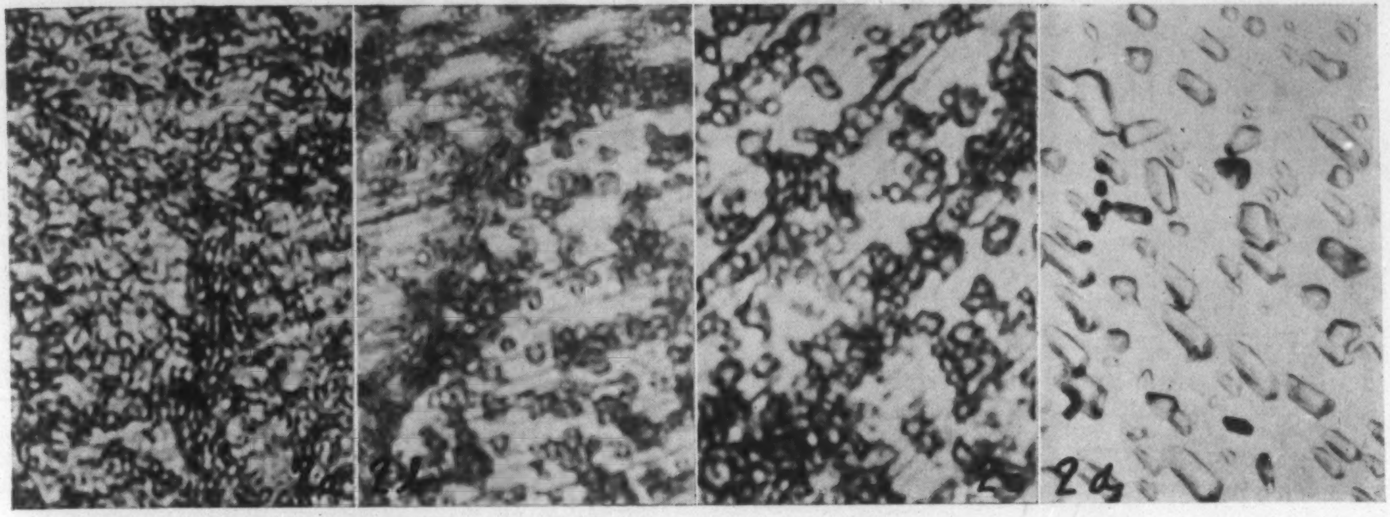

1 Hour at 530° C. 5 Hours at 530° C. 30 Hours at 530° C. 50 Hours at 460° C.

Fig. 2. Surface Precipitate Formed After Heating at Temperature and Time Indicated.

structural alterations produced by this type of deformation. The condition may be termed, but inadequately defined, as a region or boundary of localized strain. It is generally conceded that strain induced by the cold working of a supersaturated solid solution leads to an accelerated precipitation effect[14]. It has further been suggested by A. Phillips and R. M. Brick[15] and R. F. Mehl[16] that drastic cold working instead of merely initiating and accelerating precipitation may actually alter the normal solubility limits. The present work, confined to a microscopic study of one alloy, is concerned primarily with the consideration of this possibility.

For this work a 5% copper-aluminum alloy was prepared using 99.97% aluminum and high grade cathode copper. The alloy was carefully homogenized prior to rolling reductions totalling 90%. The strip was then cut into metallographic specimens which were found to be homogeneous and of the same copper concentration as indicated by chemical analysis, microscopic examination and density measurements. All specimens were then given a solution treatment of 60 hours at 545° C. and quenched in cold water. The next step was the usual metallographic polish, using 0, 00, 000 and 0000 emery paper with a kerosene lubricant, followed by polishing on wet broadcloth with levigated alumina and a final treatment on silk velvet with Fisher's No. 3 alumina. Without etching, the specimens were heat treated for varying times at temperatures under the solubility limit for this alloy and then etched with 0.5% aqueous solution of hydrofluoric acid. Fig. 1 shows the voluminous surface precipitate of $CuAl_2$ formed after 5 hours at 530°, 500°, 460° and 410° C., together with the normal structures of the metal well beneath the polished surface. The form of the precipitate, a conglomeration of rounded particles, makes good definition at a single focus rather difficult at the high magnification necessary for resolution and identification of the second phase.

These structures show in all cases a plane considerably higher in $CuAl_2$ content than can be reconciled with the equilibrium solubility relationship of this alloy system. It is perhaps of significance that after one hour at the several temperatures, all surfaces seem to contain about equal amounts of precipitate (see Fig. 2a), and even after 5 hours, the differences in quantities of surface precipitates do not seem to be as great as those noted in the normal structures. This comparison may be invalid, however, because of the difficulties encountered in estimating the relative amounts of the $CuAl_2$.

As a possible explanation of the apparently anomalous condition described, it may be suggested that the severe working induced by the polishing operations has markedly decreased the solubility of copper in aluminum. It is conceivable that zero solubility may be attained by this form of deformation. As the structural effects produced by strain are removed by subsequent heat treatment, the heavy precipitate first formed would be expected to gradually dissolve and eventually the surface revert to a condition consistent with the requirements of the constitutional diagram. Fig. 2, showing the surface after 1, 5 and 30 hours at 530°C., a temperature only some 10° below the full solution temperature for this alloy, indicates that some re-solution has taken place but is apparently proceeding very slowly.

It was also observed that in most but not all of the structures examined, the $CuAl_2$, in addition to forming a network, separated as needles or thin plates along former scratches, apparently disregarding the crystallographically preferred matrix planes (see Fig. 2c). This form of precipitation is not particularly surprising as it is quite probable that the regions directly affected by the scratching do not conform to the orientational characteristics of the underlying metal during the genesis of the precipitate. On the other hand, it is possible that pseudo-plates precipitated along the scratches consist actually of a close assembly of many small platelets each of which conforms to a normally preferred plane.

The extremely large amount of $CuAl_2$, apparently representing more than 5% copper, suggests that, in addition to the possible metastable low solubility, copper atoms have migrated from the underlayer to the surface plane and there separated as $CuAl_2$ in a manner somewhat analogous to the usual heavy grain boundary precipitate commonly found in alloys of limited solubility. It seems obvious that a surface enrichment of this character would result in a locally impoverished layer adjacent to the high copper surface. As a matter of fact such regions have been found by polishing the specimens at a very slight angle to the original surface.

This reasoning may be properly questioned on the grounds that a migration of copper atoms would not be expected to proceed into a zone in which the solubility of the copper approaches zero. In this connection it should be considered that the extreme limited solubility induced by deformation holds only so long as a strained condition exists. As soon as the altered lattice is repaired by heat treatment, the surface layer, although rich in copper in the form of $CuAl_2$, is fundamentally an unsaturated solid solution matrix. Two potential sources of copper atoms are available, i.e., from the $CuAl_2$ and the underlying solid solution layer. Apparently the copper concentration in the outer layer is increased more rapidly by the diffusion of atoms from below than by the re-solution of the compound and diffusion of the atoms thereby released. We cannot, however, account for the surface $CuAl_2$ in excess of that representing 5% copper.

The micrographic evidence seems to suggest that polishing produces a surface with some of the characteristics of crystal boundary regions. If this point of view is adopted, an attractive anology may be noted between the precipitation on polished surfaces and the boundary precipitation promoting the destructive intergranulation corrosion so frequently encountered in austenitic steels, duralumin and other industrial alloys.

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NEWS NOTES

National Metal Congress

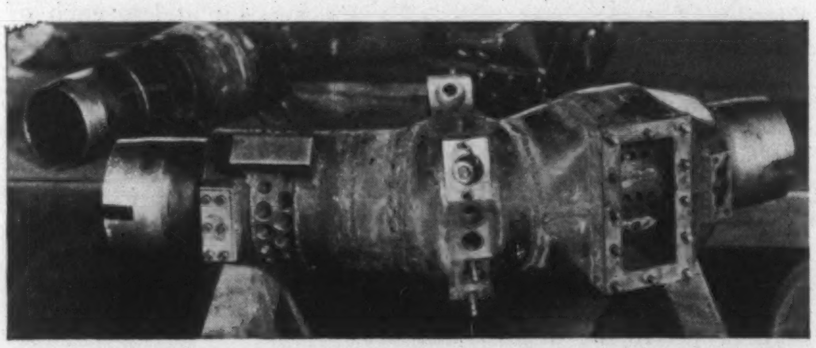
The first National Metal Congress and Exposition ever held in New York City will be the greatest since the one in Cleveland in 1929, according to the statement from W. H. Eisenman, secretary of the American Society for Metals and director of the Exposition.

The Exposition will be held Oct. 1-5, 1934. in the Port Authority Building at 14 St. and 8 Ave., and the sessions of the Congress will be held there and in Hotels Pennsylvania and New Yorker.

Members of the American Society for Metals, the Institute of Metals and Iron and Steel Divisions of the A.I.M.E. and the Iron and Steel Division of the A.S.M.E. will have headquarters at Hotel Pennsylvania. The New Yorker will be the meeting place of the American Welding Society and the Wire Association.

Diesel Engine Cylinders Built by Arc Welding

F. B. Stearns, Cleveland, Ohio, is building an experimental Diesel embodying arc welded cylinders for use in marine type engines. Since both weight and space are at a premium, arc welded steel was used for the cylinders and other parts. The cylinders illustrated are for a 320 h.p. Diesel engine operating at 1300 r.p.m. The design and arc welding of these cylinders was a difficult problem since some 16 pieces are required for each cylinder and the tolerance on the finished work was exceedingly small. The inner sleeve is of case hardened steel and the outer portions of mild steel. The arc welding was done by The Thornton Company, using welding machines and Fleetweld electrodes manufactured by The Lincoln Electric Company, Cleveland, Ohio. These are said to be the first arc welded Diesel engine cylinders ever built.



Surface Combustion Makes Foreign Installation

The foreign offices of *Surface Combustion Corporation* report much interest in modern industrial furnace developments. This interest is being manifested particularly in controlled atmosphere furnaces for bright annealing and for continuous gas carburizing. A Surface Combustion CG Gas Preparation Unit was recently purchased by Societe Anonyme des Usines Renault, Siene, France. This unit will provide atmosphere for continuous gas carburizing certain automobile parts.

Detroit Electric Appoints Case Hardening Service

Detroit Electric Furnace Company announces that the Case Hardening Service Company of Cleveland, Ohio, are sales representatives for the new rocking electric furnace recently developed in Detroit. This new furnace includes automatic timing mechanism which changes the angle of rock without operating attention. The new Detroit Rocking Electric Furnace is the smallest, most complete melting unit now offered on the market. Its capacity of 35-50 pounds is such that it is being used for industrial, foundry and laboratory applications.

Cross-Section Paper for Graphs

Cross-section paper for chart purposes, suitable for use with material being prepared for publication, is available through the Chart Production Co., 274 Madison Ave., New York, N. Y. The significant lines are ruled in red, while intermediate lines are in blue. The former appear as black, while the blue lines screen out and are not visible in the final reproduction. The paper may be obtained in two or three sizes, and is suggested to authors who are preparing material for publication in *Metals & Alloys*.

Fifth International Congress Offers Varied Program

Developments and progress in the castings industry throughout the whole world will be the theme of the Fifth International Congress to be held in conjunction with the 38th Annual Convention and Exposition of the American Foundrymen's Association in Philadelphia, Oct. 22-26. Modern developments will be presented from three angles: advances in technical knowledge, progress in operating practice, and latest design and improvement in foundry equipment. The fact that all convention activities will be held under one roof makes possible close coördination between the different interests, and meetings have been so scheduled that plenty of time is allowed for the Exposition. The program of papers, discussions, informal meeting, and exhibitions of equipment will provide valuable information on many phases of foundry work.

A feature of this Congress is the unusual number of papers from foreign foundry groups. Australia, Belgium, Czechoslovakia, England, France, Germany, and Italy are contributing papers dealing with modern foundry practice in those countries.

One of the sessions which will be of interest to all foundry men is the Materials Handling Session. Executives will find special attention given to the problem of foundry maintenance, and the selection of foundry equipment as an investment.

Refractories will be the subject of a second general interest session. Several papers of unusual practical value will be presented; among them, a discussion of the relation between slags and refractory linings, a resume of modern crucible melting equipment, and a study of the properties of clays obtained from different sources.

The shop operation course on sand control, which has been one of the most popular and instructive features of former conventions, will be repeated this year. There will also be a session on sand control and research, where questions of analysis, supplies, and methods of control will be studied.

Apprentice Training will be taken up at one session and more detailed announcement will be made later.

Cast iron founders will find an especially full program arranged for them. Two sessions, a round table luncheon, a shop operation course on cupola practice, and a joint A.F.A.—A.S.T.M. meeting on cast iron tests and specifications, have been planned.

Among the outstanding papers are those contributed by foreign foundry associations. Germany and France send papers on high-test gray iron as made in those countries. The Italian exchange paper deals with the chemical composition of common cast iron for boilers. It is expected that the Belgian exchange paper will give data on gray iron which have been collected under the auspices of the Belgian Research Foundation, and which should be of great value.

At the joint A.F.A.—A.S.T.M. meeting on tests and specifications, papers on high-chromium cast iron, and data on fatigue tests of high strength iron, will be given.

A general session on steel, another on the porosity of steel castings, and a round table luncheon are planned for steel founders. One of the most interesting papers in view is that offered by the Institute of British Foundrymen, on "Steel Castings."

Problems of solidification and contraction, and a study of controlled directional solidification, will be discussed at the general steel castings sessions.

The effect of copper in malleable iron, especially its influence on the annealing time, will be reported to those interested in malleable iron. The report of the committee on nomenclature, giving recommendations for names of different products made in malleable foundries, will be another feature of this session. The round table luncheon will deal with practical problems.

A symposium on deoxidation and degasification of nonferrous castings alloys, a general session, and a round table luncheon are on the program for nonferrous founders. At the symposium, there will be a discussion of general principles; then the meeting will take up bronze foundry alloys, yellow brass casting alloys, and aluminum and its alloys.

The general session on nonferrous castings will be rich in practical information. Porosity in leaded bronze bushings, and cupola melting of red brass, are two of the subjects to be considered.

ORE CONCENTRATION (1)

JOHN ATTWOOD, SECTION EDITOR

Flotation (1c)

Investigations into the Flotative Separation of a Mixture of Barite and Dolomite—a Contribution to the Differential Flotation of Earth Alkali Minerals (Untersuchungen über die flotative Trennung eines Gemisches aus Schwerspat und Dolomit—ein Beitrag zur differentiellen Flotation von Erdalkalimineralien) E. Ringe & E. Bierbrauer. *Berg-und Hüttenmännisches Jahrbuch,* Vol. 81, Dec. 27, 1933, pages 139-146. A new method was developed for promoting the flotation of dolomite with potassium-amyl-xanthate by the addition of $ZnSO_4$ The influence of grain-size of barite, amount of $ZnSO_4$ and xanthate on the efficiency of the separation is studied; increasing $ZnSO_4$ additions improves the separation, increasing xanthate injures it; the pulp should be kept about neutral. The grain-size of the barite should not be too fine as the separation is impaired. 6 references. Ha(1c)

A Study of Slime-coatings in Flotation. Guido R. M. del Giudice. *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 528, Feb. 1934, 15 pages. The formation of slime coatings on galena was studied by microscopic methods and the amount of sulphate ion in different liquors determined chemically. The mechanism of slime coating is discussed and it is concluded that the data prove that it is not due to electrostatic attraction as has been suggested. It seems to result from metathesis between anchored Pb ions on the galena and anchored CO_3 ions on the carbonate; this produces the almost-insoluble $PbCO_3$ which acts as a cement between galena and slime particles. Reagents that inhibit slime coating operate by reacting with sulphide mineral surface, or with the carbonate surface, or with both, to form compounds that are less soluble than $PbCO_3$. Water glass is an excellent inhibitor of slime formation on sulphide particles because the solubility of Pb silicate is very low. The influence of several addition agents on slime coating was determined. The magnitude of slime coating on galena is discussed. 18 references. JLG (1c)

Parallelism between Wetting Isotherms and Flotation Curves (Parallelismus zwischen Benetzungsisothermen und Flotationskurven). Marie Lipetz, P. Rehbinder & Marie Rimskaja. *Kolloid-Zeitschrift,* Vol. 66, Mar. 1934, pages 273-276. The predominance of capillary-physical phenomena over purely chemical phenomena in the flotation process is emphasized and scientific and practical investigations of the flotation mechanism described. The physical process is divided into 3 stages: production of an aqueous ore suspension in which adsorption of dissolved reagents to the mineral particles occurs; production of an emulsion in this suspension of gas (air) bubbles by surface-reactive agents, and fixing of imperfectly wetted or non-wettable particles to gas bubbles, producing a mineralized gas emulsion consisting of the 3 phases mineral-aqueous phase-air. The behavior of the mineral in these stages and the yield of flotation as a function of addition of reagents are discussed; the tests show that a pronounced parallelism exists between the wetting isotherms and the flotation curves. 7 references. Ha (1c)

Milling Methods and Costs at the Alaska Mine Flotation Plant of the Southern Rhodesia Base Metals Corporation, Limited, Southern Rhodesia. C. P. McMillin. *Bulletin Institution Mining & Metallurgy,* No. 353, Feb. 1934, pages 29-31. Discussion. See *Metals & Alloys,* Vol. 5, Apr. 1934, page MA 119. AHE (1c)

Amalgamation, Cyanidation & Leaching (1e)

Methods for Amalgamation Test for Platinum. I. N. Plaksin & S. M. Shtamova. *Transaction of Platinum Institute,* No. 11, 1933, pages 141-157. In Russian. The most common method for amalgamation of Pt concentrates, amalgamation with Hg in the presence of Zn amalgam, $CuSO_4$ and H_2SO_4, was investigated. Agitation method of Sharwood (Transactions American Institute of Mining & Metallurgical Engineers, Vol. 52, 1915, page 153) and amalgamation in a mortar produce too much flouring of Hg. Pebble mill is much better for the purpose. Grinding to 65 mesh was compared with grinding to 100 mesh. No difference in the amount of extraction was noted. Keeping the ratio: solid-liquid 0.7 to 1.0 constant, the amounts of chemicals added to the ball mill during amalgamation were changed. Slight variations in the amounts of the reagents used do not have any effect on the amalgamation. Pt recovery was only 55% max. Low results were due to the presence of an oxidic film on the surface of Pt. Treatment of concentrates with 0.37-0.92% H_2SO_4 for several hours removes the film of iron oxide from the surface of Pt and increases the recovery. Recommended practice of amalgamation test specifies a 12 hours agitation with 0.37-0.63% H_2SO_4 followed by standing in this acid for one or two days. Under proper amalgamation conditions (described) Pt recovery is 90 to 97.1%. Several schemes of assaying Pt products were investigated. (1e)

A New Process for Oxygenating Solutions. T. K. Prentice. *Journal Chemical, Metallurgical & Mining Society of South Africa,* Vol. 34, Feb. 1934, pages 244-263. It is essential that cyanide solutions contain O if Au is to be dissolved; the greater the amount of O, the faster the rate of dissolution. (1) Bubbling compressed air thru a cyanide solution for 30 minutes increased dissolved O from 2.5 to 3.5 mg./l.; there was no further increase up to 6 hours. Increasing CaO content from 0.008 to 0.037%, O rose to 4.5 mg. (2) Intensive agitation increased O to 4.0 mg./l. in 10 min. and 5.0 mg. in 25 min.; this was held for 20 hours after agitation stopped. Cyanide and lime consumption were increased by the treatment. (3) Bubbling compressed O through the solution at rate of 50 cc./min. increased O to 4 mg. in 2 min., 5 mg. in 4 min., and 5.5 mg. in 6 min. At 240 cc./min., O in 2 min. was 6 mg. and in 10 min. the solution was supersaturated. Cyanide consumption was not increased. (4) Passing compressed air through the solution under 6 atmospheres pressure for 20 min. and releasing left 7 mg./l. in solution. After 17 hours, O fell to 5 mg. and remained stationary. Air and cyanide consumption were negligible. Cyanide treatment of the Nourse ore, left a residue of 0.60 dwts. Au/ton. Process 1 offered no improvement; after 2, residue contained 0.42 dwt.; after 3, 0.40 dwt.; and after 4, 0.38 dwt. Normal cyanidation of 3 batches, each of 410 tons, left a residue containing 0.325-0.340, av. 0.335 dwt./ton; cyanide consumption was 72.1-79.6, av. 75.0 lbs. Using process 4, residues assayed 0.305-0.330, average 0.317 dwt.; cyanide consumption was 49.2-49.5 lbs. AHE (1e)

Milling Methods and Costs at the Golden Cycle Mill, Colorado Springs, Colo. L. S. Harner. *Mining Congress Journal,* Vol. 20, Mar. 1934, pages 29-31. Excerpts from U. S. Bureau of Mines Information Circular No. 6739. See *Metals & Alloys,* Vol. 5, June 1934, page MA 247. BHS (1e)

Milling Methods at the Oxide Conocentrator of the International Smelting Co., Tooele, Utah. J. J. Bean. *Mining Congress Journal,* Vol. 20, July 1934, pages 26-27. Excerpts from U. S. Bureau of Mines Information Circular No. 6759. See *Metals & Alloys,* Vol. 4, Apr. 1934, page MA 119. BHS (1e)

Zinc Dust Consumption at Canadian Gold Mines. A. Busson. *Mining Congress Journal,* Vol. 20, July 1934, pages 21-22. Consumption of zinc dust for gold precipitation in 26 Canadian gold cyaniding mills for 1933 was about 228 tons, varying from 0.040 to 0.2 lb. per ton of ore treated. BHS (1e)

ORE REDUCTION (2)

A. H. EMERY, SECTION EDITOR

Non-Ferrous (2a)

The Production and Treatment of Copper Precipitate. Arthur J. Caddick. *Metal Industry,* London, Vol. 44, Apr. 6, 1934, pages 366-368; Apr. 27, 1934, pages 437-439. Cu produced by leaching and subsequent precipitation by Fe is contaminated by impurities. Large scale tests showed (1) pig Fe gave a product with lower Cu but more As, (2) steel rails gave highest Cu and intermediate As, and (3) tinned cuttings ranked second in Cu content and most As. The first 2 grades of washed material yield 85% of the Cu, which may at once be melted in the reverberatory furnace or charged into the converter. The remainder contained over 1% As and large amount of Fe. Magnetic separator, or treatment with Cu liquor, or both, are used to remove Fe. As is removed by addition of soda ash. Precipitate should be dried before charging into converter. Briquetting or agglomerating is suggested as best method for charging poorer quality precipitate. The method used in direct melting of Cu precipitate in cupola type and reverberatory furnace is described. Choice of method usually depends upon local conditions. Treatment in cupola furnace is cheaper but reverberatory furnace produces higher quality product. HBG (2a)

Smelting of Ural Copper-Zinc Concentrates in the Form of Briquets. A. N. Volsky & R. A. Agracheva. *Tzvetnuie Metallui,* No. 4, May, 1933, pages 68-82. Experiments were made to determine the feasibility of economic extraction of Cu and Zn by smelting without selective flotation, concentrates assaying 12% Cu, 9.86% Zn and 31.11% Fe. Two methods were used: (1) To obtain matte, slag, and oxide of Zn, and (2) to obtain metallic Cu, slag and oxide of Zn. By the use of method 1 92-95% of Zn and 96-98% of Cu was recovered. Method 2 gave 90-92% recovery of Zn and 98-98.5% of Cu. The consumption of coal was 15-20% of the charge in method 1 and 15% in 2. Smelting of concentrates agglomerated with coal gave less satisfactory results, which may be improved by blowing pulverized coal into the molten slag. BND (2a)

Roasting Ores of Zinc and Lead (Trattamento per via termica di minerali misti di zinco e prombo). M. Gallo. *Industria chimica,* Vol. 9, Feb. 1934, pages 157-165. Low grade ores of Zn and Pb are treated to better advantage in a blast furnace than with a Wälz furnace. The advantages are: Coarse as well as pulverized materials may be treated; the fuel may be anthracite or coke, and may be added as a separate layer or admixed with the ore; less slag is formed; easily, as well as difficultly fusible ores may be treated equally well; concentrates may be produced, or zinc white may be made directly; the final product is of higher purity; fuel economy is higher, and the cost of installation and maintenance are lower. AWC (2a)

Investigation of the Harris Process (Untersuchungen über das Harris Verfahren). Bernhard Neumann & Gerhard Knoblich. *Metall und Erz,* Vol. 31, Mar. 1934, pages 121-132. The reactions taking place in the Harris process of Pb refining between the flux and the metals individually and collectively were investigated, including the effects of temperature and time. As reacts with NaOH, but Sb and Sn react only with mixtures of NaOH and $NaNO_3$; a very small concentration of $NaNO_3$ in NaOH is sufficient. In such mixtures the solubility of Pb is very low compared to that of As, Sn, and Sb. In mixtures containing mostly NaOH there is a sharp separation, by time, of the metals going into solution; the solubility is in order of As, Sb, Pb. As the speed of solution of the impurities in salt mixtures containing only small amounts of $NaNO_3$ is high it is advantageous to use small amounts of $NaNO_3$ in order to control the temperature. All reactions are exothermic. In mixtures rich in $NaNO_3$ a sharp separation of the order of solution is impossible. Early attempts using pure $NaNO_3$ were unsuccessful. The correct design of equipment for the Harris process is important. 9 references. CEM (2a)

New Electrolysis Process Gives Pure Rare Metals. *Steel,* Vol. 92, Jan. 16, 1933, page 22. See "A New Process of Electrolysis which Produces Rare Metals in Pure State," *Metals & Alloys,* Vol. 5, Mar. 1934, page MA 88. MS (2a)

Electrolysis of Sulphide Solutions. I. Electrolysis of Mercury. S. A. Pletnev & S. L. Eosunov. *Tzvetnuie Metallui,* No. 2-3, Mar.-Apr. 1933, pages 88-93. Describes the electrolytic separation of Hg and Sb from sulphide solutions obtained in the hydrometallurgical treatment of complex Hg-Sb ores, using Pt diaphragm, Fe electrodes and soda solution. Best recovery of Hg (85%) was obtained under the following conditions: current density 100 amp./m.^{2}; temperature 50° C., electrolyte concentration 7% Na_2S, 0.5% NaOH, and 30 g. Hg/1. BND (2a)

Roasting Arsenical Pyrite and Pyrite in Rotating Furnace (Röstning i roterugn av arsenikkis och svavikis). Per Aagren. *Teknisk Tidskrift,* Vol. 64, June 2, 1934, page 240. Excerpt from address before the Gothenburg Technical Society. Experience at Rönnskär, Sweden, has proved the rotating furnace ideal for this work, permitting low S in the calcine and high SO_2 concentration in the furnace gas. High roasting temperature increases speed of reaction and decomposition of sulphates. In a rotating furnace it is possible to maintain a bigger mean temperature than in a hearth furnace without danger of sintering. It is possible to obtain a product with 99.5% As_2O_3 in the gas coolers by regulating the air so that practically all of the As and only part of the S is oxidized, with an ore throughput of 100 tons/day. The gas in this case contains 5.5% SO_2 and 0.2% O_2, compared with 11-12% SO_3 and 1-2% O_2 for normal operation. BHS (2a)

Reduction of Chromic Oxide to Chromium by means of Gases (Die Reduktion von Chrom aus Chromoxyd durch Gase). H. Gruber & W. Rohn. *Heraeus Vacuumschmelze,* 10th Anniversary Volume, 1933, pages 117-127. Reduction of Cr_2O_3 over a bath of molten Fe or Ni by means of H_2 affords alloys with a max. of 17% Cr; if the H_2 is previously purified by passage through a tube cooled with CO_2 and snow or packed with P_2O_5, a max. of 25-31% Cr can be introduced into the alloy. Reduction with CO affords an alloy with a maximum of 5% Cr, and reduction with NH_3 an alloy with 18-19% Cr. More rapid reduction without removal of the last traces of H_2O from the gas can be obtained with (a) mixtures of H_2 and hydrocarbons, or (b) coal gas-producer gas mixtures containing less than 50 g. C/m.^{3} if the C in the alloy is to be kept at less than 0.05%. On a large scale reduction is effected in induction furnaces lined with MgO with a temperature of 1750-1900° and a gas speed of not more than 30m.^{3}/hr. for a surface area of 350cm.^{2} (2a)

Metering Large Direct Currents with Particular Reference to the Equipment Employed in an Electrolytic Zinc Process. Roy Scott McArthur. *Journal of the Institution of Engineers of Australia,* Vol. 5, Dec. 1933, pages 408-416. Describes the methods for accurate measurement of direct current at the Risdon Works of the Electrolytic Zinc Co. of Australasia, Ltd. These would be applicable to other cases where great accuracy is required. The development of and the necessity for such methods are traced and results of tests carried out on shunts of large capacity are described. Difficulties were encountered in obtaining 20,000 amp. shunts. Manganin with 13.6%, Mn 2.5% Ni, 9.3% Fe and the balance Cu has been preferred because of its low thermo-electric value. The shunt can be run at a high temperature for which purpose a relatively smaller shunt can be used. However Manganin cannot be soft soldered into the metal ends of the shunt and must be brazed to obtain a reliable joint which adds to the difficulty in constructing a large shunt. Cupro-nickel with 5-25% Ni overcomes the joining difficulties but cannot be operated at too high a temperature. WH (2a)

Soderberg Electrodes in Aluminum Industry. Closed Aluminum Cells (L'électrode Soderberg dans l'industrie de l'aluminium. Les cuves à aluminium fermées). Sem. *Journal du Four Electrique,* Vol. 43, June 1934, pages 208-211. The use of Soderberg electrodes in Al manufacture permits continuous operation with the saving of 15-20% usually lost as electrode butts. An automatic regulation of the planeness of the immersed surface, impossible with the usual multiple electrode cells, is entirely feasible with a single large electrode of this type. They are made by filling a properly shaped aluminum shell with the prepared electrode mass. Current is introduced through steel pins inserted in rows into the surface of electrodes before baking. Only the lowest row is operating and the pins are removed when they approach the bath closely. Continuous operation permits closing the furnace so as to remove F_2 into washing towers. Closed cells with 22,000-25,000 amps. have operated since 1932 and 55,000 amp. furnaces are being installed. An average for 3 months current consumption of cells using 45,000 amps, was 16,650 KWH/ton. Absorption of F permits the recovery of 50% of the cryolite used in the operation of closed cells. JDG (2a)

Making Ferro-silicon With Calcined Pyrites. S. I. Hitrik & A. E. Poznanski. *Domez,* 1934, No. 2-3, pages 37-44. (In Russian.) Comprehensive report of experimental melts made in a 68 x 68 x 60 cm. electric arc furnace. Calcines contained 11.75% SiO_2, 1.92% S and 0.88 Cu. S is eliminated within the permissible limits. Cu is retained in different amounts. Fe ore is better for the purpose than the calcined pyrites. (2a)

Ferrous (2b)

Sintering Plant at the Ford Works. The Latest Scientific Principles. *Iron & Steel Industry & British Foundryman,* Vol. 6, Sept. 1933, pages 411-412. A Dwight-Lloyd plant for sintering Fe ore erected in the Ford plant, Dagenham, England, is described. Capacity is 600-700 tons/24 hours and operating cost is $0.50 or less/ton of sinter. CHL (2b)

The Iron Blast Furnace. T. L. Joseph. *United States Bureau Mines, Information Circular.* No. 6779, May 1934, 29 pages. General, including a discussion of combustion in front of tuyères, factors controlling distribution of gas, cause and control of size segregation, effect of sizing feed, conditions inside the furnace, etc. AHE (2b)

Principles of the Design of Blast-furnace Lines. Jindrich Sarek. *Iron & Steel Institute, Advance Copy* No. 18, May 1934, 25 pages. A new method of designing blast-furnace lines is suggested, the principles of which are deduced from changes undergone by the burden as it descends in the furnace. This method calls for a knowledge of the character of the ores smelted and of the coke used, and requires a temperature diagram for the charge worked. Coefficients that are needed for calculation of individual dimensions can be measured or estimated with a sufficient degree of accuracy. JLG (2b)

Effect of Gas Velocity on the Blast Furnace. S. P. Kinney. *Blast Furnace & Steel Plant,* Vol. 22, Mar. 1934, pages 152-154,165; Apr. 1934, pages 209-211, 213. Continuation of field investigations of the U. S. Bureau of Mines on flow of gas in the stock column of the Fe blast-furnace. Study was made on the West furnace of the American Rolling Mill Co., Columbus, O. The composition, temperature, and velocity of gas from the inwall to the center of the furnace on 2 planes,—3 ft. and 14 ft. below the top of the stock column were determined. Results show that gas flow in the upper portion of the shaft, near the stock-line, is not uniform. Gas near the inwall is low in CO_2 and is passing up the shaft near the wall at high temperatures and at high velocity. High gas velocity at the inwall is directly responsible for excessive wear and the ultimate deterioration of the stock-line section of the furnace shaft. Decreased velocities at the inwall, with a resultant lowering of flue-dust production, may be obtained by increasing the diameter of the shaft below the stock-line. MS (2b)

An experimental Enquiry into the Interactions of Gases and Ore in the Blast-furnace. Part III—Proposed Methods for Comparative Testing of Iron Ores. William A. Bone, H. L. Saunders & N. Calvert. *Iron & Steel Institute, Advance Copy* No. 5, May 1934, 14 pages. In determining the reducibilities of 5 Fe ores the 2 following reactions were studied: (1) the C deposition resulting from the catalytic reversible reaction $2CO \leftrightarrows C + CO_2$, and (2) the direct reduction of the ore by CO, $Fe_xO_y + CO \leftrightarrows Fe_xO_{y-1} + CO_2$. The first reaction was studied at 450°C. and the second at 750°C. The ores used were a Barrow hematite, a Spanish rubio, a Linconshire, a Cleveland, and a Mesabi. The gas contained 1/3 CO and 2/3 N_2. The rates of reaction were obtained in a specially constructed apparatus and varied appreciably for the different ores. At 750°C. the rate of reduction of the Barrow hematite was less than that for any other ore. JLG (2b)

An Experimental Enquiry into the Interactions of Gases and Ore in the Blast-furnace. Part IV—Equilibria and Velocities in Ore Reduction. William A. Bone, H. L. Saunders & J. E. Rushbrooke. *Iron & Steel Institute, Advance Copy* No. 6, May 1934, 26 pages. Equilibria in the reaction $Fe_xO_y + CO \leftrightarrows Fe_xO_{y-1} + CO_2$ at 1150° C. were determined by measuring the equilibrium value of the CO/CO_2 ratio for different amounts of reduction of the ore. Results indicate that reduction involves 3 successive stages: $Fe_2O_3 \longrightarrow Fe_3O_4 \longrightarrow FeO \longrightarrow Fe$. The same 3 successive stages are involved in the reduction of Fe ore by H at temperatures between 450 and 850°C. Relative rates of reduction for several velocities of blast-furnace gas at temperatures up to 1000°C. were determined. JLG (2b)

Trials of Moisture Measuring Instruments for Dust-Containing Industrial Gases (Betriebserfahrungen mit Feuchtigkeitsmessgeräten für staubhaltige Industriegase). K. Guthmann. *Archiv für das Eisenhüttenwesen,* Vol. 7, June 1934, pages 673-677. Service tests of various instruments for measuring the moisture content of blast furnace gas were made. A Siemens & Halske recording instrument which gave very sensitive and precise results is described. SE (2b)

Iodine in Blast Furnace Gas Dust. F. Wald. *Engineering,* Vol. 137, May 18, 1934, page 579. A paper presented before the 12th Congress of Industrial Chemistry, Prague, 1932. The composition of the dust in blast-furnace gas was studied. Over a period of 1 year, a monthly average of 0.21% I was obtained; on certain days it ranged as high as 0.27 to 0.28%. LFM (2b)

Use of Burned Limestone as a Flux in the Blast Furnace (Verwendung von gebranntem Kalkstein als Zuschlag im Hochofen). E. Baumgartner. *Stahl und Eisen,* Vol. 54, May 24, 1934, pages 509-512. Raw limestone in the blast furnace increases coke consumption and since the Kladno ores in Czechoslovakia require large lime additions special furnaces were installed for burning limestone. These are described. Use of the burned limestone in the blast furnace favorably affected coke consumption, furnace operation, yield, blast furnace gas, and pig Fe composition. SE (2b)

Sintering Nikopol Manganese Ore and Experiments of Smelting Ferromanganese using Sinter. G. G. Oreshkin. *Domez,* No. 1, 1934, pages 12-19. (In Russian). Using first class Mn ore in a Greenawalt sintering machine, a 6% coke charge and 30 minute sintering cycle was best. With larger coke addition or longer cycle there was too much superficial fusion. In tests up to 65 hours, addition of 30% of these agglomerates to the charge of Fe-Mn in a blast furnace lowered the top temperature from 550° C. to 420° C., reduced coke consumption, and increased furnace production from about 125 tons to about 140 tons. The quality of the gas produced was entirely satisfactory for plant use. (2b)

MELTING, REFINING & CASTING (3)

Sand Control on a Continuous Molding Unit in a Malleable Foundry. Charles Morrison. *Foundry Trade Journal,* Vol. 59, Oct. 19, 1933, pages 215-216 and 225. Paper read before the American Foundrymen's Association. See *Metals & Alloys,* Vol. 5, Apr. 1934, page MA 121. OWE (3)

Production of High Melting Point Metals by Thermal Dissociation of their Compounds (Über die Herstellung von hochschmelzenden Metallen durch thermische Dissoziation ihrer Verbindungen). A. E. van Arkel. *Metallwirtschaft,* Vol. 13, June 8, 1934, pages 405-408. Metals can be produced in very pure form by heating one of their compounds in an evacuated vessel, providing the compound will dissociate into the metal and gas at a temperature below the melting point of the metal. In this method the metal is not melted and does not come in contact with impurities. W can be prepared by heating WCl_6 in an evacuated pyrex tube to about 300° C., which causes it to volatilize. In the upper part of the tube a W wire is heated electrically to 1400°. This temperature causes the WCl_6 to dissociate, pure W is deposited on the wire, which grows uniformly, and Cl gas is liberated. The Cl combines with W powder which has been placed in the tube and the process continues until the W powder is used up. Wires of several mm. diam. can be prepared in this way. By similar processes Si, Nb, Ta, Mo, and Re can be produced from their chlorides, B from BBr_3, Be, Cu, Ti, Zr, Hf, Th, V, Cr, and Fe from their iodides, Ni from Ni carbonyl and Pt from Pt carbonyl chloride. The temperature to which the compounds and the metallic wires should be heated and the means for removing the gas formed are given. It is also possible to produce some alloys and compounds by this method. CEM (3)

The Manufacture and Application of Centrifugal Castings. T. R. Twigger. *Foundry Trade Journal,* Vol. 49, Dec. 7, 1933, pages 321-323. An article dealing with historical aspects of the subject, then discussing speed of rotation, working temperature, and life of molds. The improvement in quality and strength that results from centrifugal casting of a given alloy is noted. Applications of centrifugal castings are dealt with in considerable detail. OWE (3)

Increasing Capacity of Graphite Crucibles (Wie erhöhe ich die Leistung des Graphitschmelztiegel?) Max Schied. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Apr. 29, 1934, pages 187-191; May 13, 1934, pages 205-208. Discusses savings effected by use of high quality crucibles due to longer life and decreased metal oxidation loss. The following points are stressed in particular: (1) necessity of adjusting crucible shape to melting furnace, (2) proper crucible size, (3) proper storing of crucibles, (4) proper heating, slow heating to red heat and subsequent rapid heating to white heat, (5) proper seat of crucible on stand, (6) use of melting coke of proper size and quality, (7) careful removal of slag, (8) proper insertion of crucible in tilting furnaces, (9) cautious charging of crucibles, (10) proper application of metal covering fluxes, (11) avoidance of impinging flames during melting process, (12) careful observation of melting process, (13) avoidance of injuries during deoxidation and charging of coke, (14) proper fit of crucible tongs, (15) careful treatment of crucible after use. GN (3)

Loam Cores (Noyautage de Formes en Terre). A. Philippart. *La Fonderie Belge,* Vol. 2, Mar.-Apr. 1933, pages 37-42. Technical Committee Report of the Belgian Foundry Association. Construction and sweeping of large parallelopiped shaped cores are explained and illustrated. FR (3)

The Manufacture of Castings for the Electroplating Industry. G. C. Pierce. *Electrometallurgy,* supplement to *Metal Industry,* London, Vol. 44, Apr. 6, 1934, pages 375-376. (A paper presented at a Joint Meeting of the Electrodepositors' Technical Society and the Institute of British Foundrymen at Northampton Polytechnic, London, Jan. 10, 1934.) Loose grains of sand not removed from the mold prior to pouring is a common cause of skin porosity of castings for electroplating. Other causes are (1) weakness of facing sand, due to improper tempering and bonding; (2) improper ramming; and (3) poor location of runners. The proper method of facing the mold to obtain a good skin is indicated. The need of the proper selection of metal is emphasized. Experiments were conducted with cartridge brass, without additions, and with additions of 6 and 15% Pb respectively. Comparisons are given of color and weight, and data from test-bars poured in each heat for tensile strength, elongation and Brinell hardness. The need for pyrometric control is pointed out especially, since most work to be plated is of thin section thus requiring a high pouring temperature. "Speckiness" of the surface of iron castings is given as one reason why this type is unpopular for plating. A good surface is necessary and may be obtained more cheaply by the use of a proper facing sand than by surface-grinding. The author recommends for light iron castings with a section of 0.10" to 0.25", the following mixture to produce a superior skin:—"20 parts of cleaned and screened old sand, 5 parts of screened new sand; and 2 parts of superfine coal dust." The latter should be of good quality and pass through a 90-mesh sieve. Coal dust is preferred to plumbago for with the latter, unless extreme care is used, "kish" will be formed and a poor surface produced. Coarse coal dust will produce a pitted surface on thin castings but may be used on heavier sections. Porosity of iron castings is briefly mentioned. The fallacy of classifying all defects as "blowholes" is commented upon. Many of the difficulties encountered by the plater are attributed to a lack of metallurgical knowledge on the part of the designer. The question of cost is considered. It is pointed out that since only castings of extremely good quality can be satisfactorily plated, the purchaser must expect to pay a higher price for this work than for ordinary castings. HBG (3)

Solidification of Foundry Alloys. Albert Portevin. *Metal Progress,* Vol. 25, Mar. 1934, pages 44, 46. A good idea of "foundry properties" of alloys can be obtained by a consideration of the solidification in three parts, (1) solid crystals are discontinuous and float in liquid, (2) crystals are in contact and form a sort of filter through which the liquid may circulate, and (3) bridges or diaphragms of solid are formed and liquid is discontinuous. The importance of these periods in the solidification of a given casting depend on size as well as the solidification of the alloy. WLC (3)

Cast Iron in Chemical Equipment. Willard H. Rother. *Foundry Trade Journal,* Vol. 49, Aug. 17, 1933, pages 107-108. See "Utilizing Cast Iron in Chemical Equipment," *Metals & Alloys,* Vol. 5, June 1934, page MA 285. OWE (3)

Design and the Foundry. T. R. Harris. *Foundry Trade Journal,* Vol. 50, Jan. 25, 1934, page 75. Harris illustrates the importance of submitting designs of castings to foundry authorities for their opinion before finally deciding upon the design. OWE (3)

A Metallurgist's Outlook on Modern Foundry Production. J. R. Handforth. *Foundry Trade Journal,* Vol. 50, Jan. 4, 1934, pages 11-14. Paper covering the whole field of foundry practice and touching on steel, iron, copper alloy, aluminum, and magnesium products of the foundry. OWE (3)

Transportable Sand-Regenerating Apparatus (Les Appareils régénérateurs de Sable sur Place). E. Monnot. *Revue de Fonderie Moderne,* Vol. 28, Apr. 25, 1934, pages 118-119. Automatic, transportable arrangement for sifting and cleaning used foundry sand to be used in a convenient place in the molding shop. Ha (3)

The Use and Abuse of Chaplets. T. R. Harris. *Foundry Trade Journal,* Vol. 50, Mar. 8, 1934, page 164. Article accompanied by 5 diagrams which illustrate points raised by Harris in regard to the subject. OWE (3)

Commercial Moulding Sand Control for the Modern Ironfounder. F. HUDSON. *Foundry Trade Journal,* Vol. 49, Dec. 21, 1933, pages 351-352, 360; Dec. 28, 1933, pages 369-372. Article, in 2 parts, dealing (1) with plant and control methods and (2) *in extenso* with benefits to be gained by molding-sand control. Green sand vs. dry sand and benefits resulting from sand control are briefly noted. OWE (3)

The Patternmaker's Foundry Sense. F. C. EDWARDS. *Foundry Trade Journal,* Vol. 50, Feb. 1, 1934, pages 89-92. Indicates how a sense of foundry requirements will enable the patternmaker to produce for the foundryman patterns suitable for the production of first-class castings. OWE (3)

Patternmaking. F. C. EDWARDS. *Foundry Trade Journal,* Vol. 50, Feb. 22, 1934, pages 129-131, 133; Mar. 1, 1934, pages 145-147, 151. Edwards discusses difficulties met in preparing patterns, which leads to a discussion of the outstanding essentials in patternmaking, namely, the use of suitable materials and the employment of proper methods of construction. A variety of examples and the value of plywood in patternmaking are discussed. Finish, pattern colors, numbering and storage of patterns are also dealt with. OWE (3)

Ferrosilicon (Contribution a l'etude des ferrosiliciums). H. DELOMENIE. *Comptes Rendus,* Vol. 197, July 17, 1933, pages 249-252. Compares industrial ferrosilicons with alloys prepared in laboratory by mutual fusion of purest Fe and Si obtainable, in a vacuum furnace, using zirconia crucibles. See also *Metals & Alloys,* Vol. 5, June 1934, page MA 286. OWE (3)

Rustless Steel Castings for Paper Industry. G. L. COX & F. L. LA QUE. *Iron Age,* Vol. 131, Mar. 2, 1933, page 347. Abstract of paper read before the Engineering Division of the Technical Association of the Pulp and Paper Industry. See "Chromium-Nickel-Iron Castings from Sulphite Service," *Metals & Alloys,* Vol. 5, June 1934, page MA 285. VSP (3)

Foundry Development. J. H. ANDREW. *Foundry Trade Journal,* Vol. 50, Jan. 18, 1934, pages 37-38. Andrew emphasizes the desirability in work on cast iron of taking thermal heating and cooling curves of every alloy. The latter part of the paper deals with non-ferrous foundry practice. OWE (3)

Rules for Purchasing Molding Sand (Richtlinien für den Bezug von Formsand) GUSTAV KREBS. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, May 13, 1934, pages 199-202. Paper considers in particular physical properties that good molding sands should possess. Average compositions of good molding sands are given. There are further discussed determination method of pore volume, change of molding sand in molding and casting, determination of grain size, deposits of suitable molding sands in Germany, suitable sand mixtures for various type castings. GN (3)

Non-Ferrous (3a)

G. L. CRAIG, SECTION EDITOR

The Casting of Brass Ingots. *Engineer,* Vol. 157, Apr. 13, 1934, page 376. Very brief outline of material covered in the Third Research Monograph by R. GENDERS & G. L. BAILEY issued by the British Non-Ferrous Metals Research Association. See *Metals & Alloys,* Vol. 5, June 1934, page MA 250. LFM (3a)

Some Aspects of Non-Ferrous Founding. ARTHUR LOGAN. *Foundry Trade Journal,* Vol. 50, Mar. 22, 1934, pages 193-195; Mar. 29, 1934, pages 211-213. Illustrated article, dealing with difficulties due to improper foundry practice. Such factors as casting temperature, gas evolution, etc., are considered. Methods of repairing castings, particularly "burning on," are dealt with at length. (3a)

Prevent Losses with Proper Gates and Risers. PAT DWYER. *Foundry,* Vol. 61, Aug. 1933, pages 31-32, 34; Vol. 61, Sept. 1933, pages 30, 32, 35; Vol. 61, Oct. 1933, pages 34-37; Vol. 61, Dec. 1933, pages 36-37, 39. *43rd installment.* Total shrinkage in group of castings of like cubical content is the same. In thin castings of large area shrinkage is diffused to such an extent that it is not apparent. In thin castings total shrinkage is concentrated in a small area and shows up as cavity unless precautions are taken. Shrinkage preventative measures include gate design, feeding risers and both internal and external chills. In some cases a combination of remedies are required. Pouring different parts of castings with metal of varying temperature sometimes is adopted to equalize cooling speed. *44th installment.* Primary requisites in production of sound Al castings is to pour the metal into mold without excessive agitation or splashing. The reason is that all exposed surfaces of Al whether solid or molten are covered with a layer of Al_2O_3. If it is broken the freshly exposed surfaces become oxidized immediately. Metal from lip of ladle or crucible held close to sprue will enter the mold more quietly than metal falling from lip held high above sprue or pouring basin. *45th installment.* Describes the use of X-rays in the examination of castings for hidden defects. *47th installment.* Attempt to cast Al parts exceeding 10 lbs. involves great difficulty in permanent molding. High grade cast Fe for permanent mold construction is preferred. If any part of Al casting is to be machined, that is the logical place to locate the gate unless danger of trapping air makes it impracticable. Best size of sprue and gate can only be determined by cut and try method. Risers are not often used. Permanent molds for Al should always be coated before pouring metal. Cracks in castings are due to faulty molds. VSP (3a)

Difficulties in Casting Brass and Bronze Alloys (Schwierigkeiten beim Giessen von Messing- und Bronzelegierungen) W. FRÖLICH. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Mar. 4, 1934, pages 97-99. On basis of his practical experience author discusses a number of difficulties arising in casting brass and bronze alloys. Upon casting propellers of Mn bronze, for instance, castings were unclean and distorted and possessed black spots. In using pure virgin brass to which Mn had been added in form of preliminary alloys or by using brass remelted under salt cover in conjunction with the arrangement of a horn-like type of gate, ship propeller castings were obtained that were absolutely dense, true to dimensions and free of defects. Similarly difficulties apparent in making castings of screw conveyors could be eliminated. A simple method for determination of Zn-loss in melting brasses and bronzes is described. Finally molding and casting procedure of round bars made of an alloy containing 83% Cu, 7% Zn, 5% Pb and 5% Sn cast in sets of 7 pieces together are discussed. GN (3a)

Difficulties in Processing Non- Ferrous Metal Castings (Schwierigkeiten bei der Herstellung von Metallguss) W. FRÖLICH. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Mar. 18, 1934, pages 119-122. The following cases are considered. (1) Difficulties in melting Ni castings (porosity) can be eliminated by adding small amounts of Mg (.10-.20%), (2) success in casting short flanged tube pieces made of bronze, Mn brass and similar alloys depended on gating method of which 4 different types are discussed, (3) continued failure in casting Pb bearing red brass (85% Cu, 6% Zn, 4% Sn and 5% Pb) was eliminated by first treating molten metal with NaCl and subsequently with mixture of calcinated caustic soda and milled lime, (4) unsound castings were obtained in casting tube sockets for locomotives made of different types of Cu-Zn-Sn-Pb alloys. By using these different types of alloys failure could not be eliminated by described special cooling method finally adopted, (5) failures are frequently due to changes in metal composition upon melting. A simple mechanical test (sawing test) for rapidly determining Zn content of brass is described, (6) in making a certain type of Al casting, original composition 90.6% Al, 8% Cu, 1% Fe, .4% Si, later changed to 89% Al, 8% Cu, 3% Si use of pure raw materials and special gating method (horn-like gates) were found necessary for obtaining sound castings, (7) finally a method for cleaning Al castings without destruction of casting skin is described. Castings are first dipped for a few sec. in alkali solution and subsequently in mixture of 33% 60° Bé H_2SO_4 + 66% 38° Bé HNO_3. GN (3a)

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Waste-heat Boiler Practice at the United Verde Copper Company Smelter. J. R. MARSTON. *Transactions American Institute Mining & Metallurgical Engineers, Copper Metallurgy,* Vol. 106, 1933, pages 246-250. Describes equipment and operation. JLG (3a)

Montreal East Plant of Canadian Copper Refiners Limited. H. S. MCKNIGHT. *Transactions American Institute Mining & Metallurgical Engineers, Copper Metallurgy,* Vol. 106, 1933, pages 352-368. The electrolytic plant contains 432 commercial cells and 36 stripper cells. The cells are built in tiers of 9 cells to the tier and arranged in sections containing 2 tiers. The commercial cells are 16 ft. 7 in. by 3 ft. 7½ in. inside and have an inside height of 4 ft. 1½ in. They are built of concrete. There is an anode furnace holding 150 tons of Cu and a wire-bar furnace holding 350 tons. A Ag refinery treats the slimes. Details of equipment and operation are given. JLG (3a)

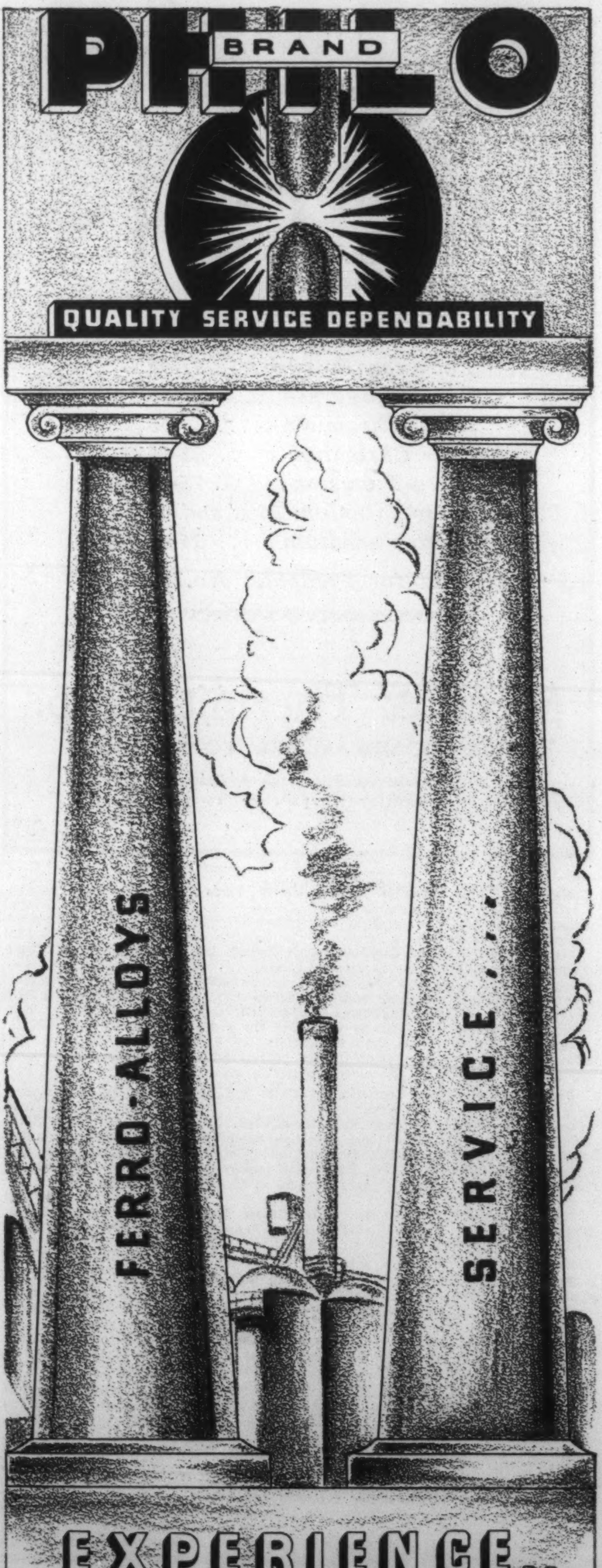
Development of Copper Converting at Butte and Anaconda. WILLIAM KELLY & FREDERICK LAIST. *Transactions American Institute Mining & Metallurgical Engineers, Copper Metallurgy,* Vol. 106, 1933, pages 122-131. Describes Cu converters used from 1884 to date. The first Cu converter in this country was installed in 1884. Drawings and photographs of the converters used at different periods are shown. Basic-lined converters holding about 75 tons of matte are used now. These produce 85 tons of Cu per day from 45% matte. JLG (3a)

The Metallurgical Plant of the Andes Copper Mining Company at Potrerillos, Chile. L. A. CALLAWAY & F. N. KOEPEL. *Transactions American Institute Mining & Metallurgical Engineers, Copper Metallurgy,* Vol. 106, 1933, pages 678-728. Describes plant. JLG (3a)

Preparation and Properties of Gallium and Gallium Trichloride. WILLIAM M. CRAIG & G. WILSON DRAKE. *Journal American Chemical Society,* Vol. 56, Mar. 1934, pages 584-585. In the commercial purification of Zn by redistillation at a low temperature a Pb dross is left behind as a residue. This article describes an easy and rapid method for the separation of traces of Ga from Pb dross by means of fused Pb cloride. The m.p. of metallic Ga was found to be 29.755°, the density, 5.903 g. per cc. at 25°, and the atomic volume, 11.81. Pure Ga shows little tendency toward supercooling. MEH (3a)

Cast Metal (Dental) Bases. FREDERICK W. FRAHM. *British Journal of Dental Science and Prosthetics. Prosthetics Section,* Vol. 78, Dec. 1933, pages 334-338. Abstracted from *Dental Items of Interest.* The gravity. centrifugal, and pressure methods of casting dental bases in aluminum, tin, and gold are briefly described. JCC (3a)

Separation of Cobalt and Nickel in Aqueous Solution for the Practical Recovery of the Two Metals (Beiträge zur Trennung von Kobalt und Nickel in wässeriger Lösung zwecks praktischer Gewinnung der Einzelmetalle) H. GROTHE. *Metall und Erz,* Nov. 1933, pages 449-455. The theory of precipitating Co with NH_4OH and $(NH_4)_2SO_4$ from solutions containing Co and Ni is discussed. The amount of Ni precipitated from Ni solutions and of Co from Co solutions under various conditions of temperature, reaction time, and NH_4OH concentration was determined. Co precipitates in a much shorter time than Ni, about ½ min., and temperature and concentration have less effect on the Co than on the Ni reaction. From a solution containing equal parts of Co and Ni a maximum of 96.5% Co can be precipitated with 3 molar NH_4OH, but considerable Ni also precipitates. When $(NH_4)_2SO_4$ is also added the amount of Ni precipitating should theoretically be reduced, but actually it is not. Apparently the Co and Ni form a complex insoluble compound. It is best to add the NH_4OH to a cold solution, then heat slightly. By repeated treatment with NH_4OH Co containing only .5% Ni can be obtained, with a loss of 2.7% Co. The Co precipitate is ignited to the oxide and the Ni solutions can be used for electrolytic production. 16 references. CEM (3a)



The Nichols Series System of Electrolytic Copper Refining. C. S. Harloff & H. F. Johnson. *Transactions American Institute Mining & Metallurgical Engineers, Copper Metallurgy,* Vol. 106, 1933, pages 398-407. Describes operation of series equipment at plant of Nichols Copper Co. Special attention is paid to improvements in equipment and operation introduced since the World War. The plant now treats low-grade as well as high-grade blister. JLG (3a)

The Anode Department of the Noranda Smelter. W. B. Boggs & J. N. Anderson. *Transactions American Institute Mining & Metallurgical Engineers, Copper Metallurgy,* Vol. 106, 1933, pages 329-351. See *Metals & Alloys,* Vol. 4, page MA 270. JLG (3a)

On the Application of Aluminum Scrap in Foundries (Zur Verwendung von Aluminiumabfällen in der Giesserei) W. Fröhlich. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Feb. 18, 1934, pages 75-76. Discusses efficient use of low grade Al scrap in processing Al castings. Considered are use of Al chips, contaminated sheet, wire products, and scrapings. Sound Al castings made by using waste metal can be obtained only when scrap is first cleaned and used in recast state. Best melting procedure is outlined. In melting, heavy scrap must first be charged in empty crucible. Use of fluxes during melting period is not advisable. After melting down a flux of 80% $NaCl + 20\% CaF_2$ should be added for purification of melt. To attain this, temperature of melt should be raised to 800°-850°C., flux and melt may react at this temperature for 1-2 hrs., melt is then allowed to cool to 700°C. and cast at this temperature. GN (3a)

Decomposition of Cuprous Oxide by Carbon Monoxide and Deoxidation of Red Brass by the Process of Reitmeister (Ueber den Abbau des Kupferoxyduls durch Kohlenoxyd und die Desoxydation von Rotguss nach dem Verfahren von Reitmeister) H. Nipper & P. Roentgen. *Die Giesserei,* Vol. 21, Mar. 2, 1934, pages 86-89. The presence of cuprous oxide in cast Cu alloys results in a lowering of its mechanical properties. According to Reitmeister the use of CO *in statu nascendi* is particularly suitable for the elimination of this defect in red brass. CO is generated in the melt by introduction of a metal oxide and coal in stoichiometrical ratio. The possible reactions going on when Cu_2O, ZnO, SnO_2 or PbO are used as oxide are discussed; the reaction depends on the ratio of surface to volume, the ability of the reagents to diffuse and the concentration gradient. The affinity of CO to O is considerably greater than that of Cu to O so that if Cu, O, and CO meet only CO_2 will be formed at the melting temperatures of Cu and its alloys. 9 references. Ha (3a)

Ferrous (3b)

C. H. HERTY, SECTION EDITOR

Precautions to be Taken in Manufacture of Ferrochrome in Electric Furnaces (Des précautions à prendre dans la fabrication du ferro-chrome au four electrique). N. Volianik. *Journal du Four Electrique,* Vol. 43, Mar. 1934, pages 90-91. General recommendations. Deals with Fe-Cr having more or less than 6% C. For lower C the charge must be higher in C to prevent absorption of it from electrodes, slag more siliceous and contain more Cr_2O_3. Coke and ore should be graded to size. Melting with low level of the bath is much to be preferred. JDG (3b)

What Should Govern Cupola Slag. Fred J. Walls. *Foundry,* Vol. 62, May 1934, pages 18-19, 48. In making up cupola charge it is important to create a slag having as low a fusion point as is consistent with conditions present. To show unknown variation in cupola slag formation a theoretical burden calculation is made on one day's full operation. Samples were taken at regular intervals, mixed and analyzed. Analyses show that foreign material was picked up, either from melting zone patch or from materials charged or from both, and converted into slag. Gives also calculation showing amount of each element necessary to produce a slag. In blast furnace operation sometimes a scaffold forms in bosh or a few ft. above tuyeres. In such cases a good dose of sharp sand acts as a strong cathartic and removes infection. VSP (3b)

Foundry Handling and Conveying. R. Spriggs. *Foundry Trade Journal,* Vol. 49, Nov. 16, 1933, pages 279-280, 282. Spriggs discusses the mechanization of foundries, dealing first with the psychological attitude towards mechanization, and then describing methods of mechanization which have been and can be adopted in foundries of various types. OWE (3b)

Some Points in Electric Steel Making. Victor Stobie. *Foundry Trade Journal,* Vol. 50, Feb. 1, 1934, pages 83-84. Stobie discusses at considerable length the process of manufacturing steel in the arc-electric furnace, dealing with the chemistry of the process and with points to be observed when installing and using the furnace. The matter of electrode consumption is dealt with at length, attention being called to the increase in electrode life which results from the use of the Stobie economizer. Some attention is also directed to high-frequency-furnace practice, particularly to the use of the Witton high-frequency furnace (Stobie patents). OWE (3b)

Modern Iron Foundry Practice. R. C. H. Weeks. *Foundry Trade Journal,* Vol. 50, Mar. 8, 1934, pages 165-168. Weeks discusses the melting plant of the modern iron foundry, and in particular the balanced-blast cupola, the Brackelsberg and the Sesci furnaces. Attention is directed to cupola linings and patchings, to mechanical charging, to facing sand and the action of coal dust in facing mixtures, to foundry sands and cores, and to methods of manufacture in one or two works. Reference is made to alloy cast irons for special purposes, to desulphurization of cast iron, and to radiographic inspection of cast iron. OWE (3b)

Weigh All Air Entering the Cupola. Alexander W. Weston. *Foundry,* Vol. 61, Oct. 1933, pages 24, 57. Cupola equipped with a positive pressure blower improves operation and effects a saving in melting costs. Benefits include a saving in fuel, hotter Fe, less patching in melting zone, greater uniformity in operation, lower loss of Si and Mn by oxidation and less S pickup. Control equipment necessary for weighing the air include a barometer, thermometer and volume meter. The variables, Fe, coke and air should be under control. Includes method of calculating amount of air to be used and gives several examples VSP (3b)

Residual Metals in Open-Hearth Steel. Clyde E. Williams & John D. Sullivan. *Metals & Alloys,* Vol. 4, Oct. 1933, pages 151-152. 18 steel companies coöperating with Battle Memorial Institute are studying the matter of residual metals in steel. The results of analysis of quarterly, semi-annual and annual composite samples from Mar. 1931 to Jan. 1933 are shown in graphic and tabular form. WLC (3b)

Iron and Steel Metallurgy: A Review of the Literature. Clyde E. Williams, V. N. Krivobok & C. H. Herty, Jr. *Mining & Metallurgy,* Vol. 14, Jan. 1933, pages 17-21. Discuss the development of Fe and steel metallurgy during the past year. Some of the developments are the Edwin-Norsk-Staal process; Effect of the use of molten Fe or cast pig Fe on the quality of open-hearth steel (still unsolved); Use of luminous vs. non-luminous combustion of gas in various types of reheating and heat treating furnaces; and V addition in medium Mn cast steels which resulted in a general improvement in physical properties. Some of the outstanding publications of the year were "Symposium on steel castings"; Paper by C. E. Sims and G. A. Lilliequist showing that the type of non-metallic inclusion present in cast steel was the controlling factor in determining ductility of steel; Various theories of age hardening by P. D. Merica; C. E. Williams and J. D. Sullivan giving results of a 3 year survey on alloy contamination of open-hearth steel; and several others. VSP (3b)

Railway Foundry Mechanization. E. A. W. Turbett. *Foundry Trade Journal,* Vol. 50, Jan. 18, 1934, pages 47-48, 50. Turbett discusses the question of mechanizing railway foundries and offers examples of improvements that result from mechanization. OWE (3b)

Improved Gray Iron Structure Without Chill Obtained in Centrifugally Cast Pipe. *Iron Age*, Vol. 133, Feb. 8, 1934, pages 26-29, 66. Describes the development in the manufacture of de Lavaud centrifugally cast pipe by United States Pipe and Foundry Co. It consists of applying powder to inside of permanent mold casting machine in such a way that not only is chilling of Fe prevented but a grain structure is obtained that imparts increases in both strength and ductility. Method of applying powder is also of importance. Any one of several powders will perform satisfactorily. Describes a number of impact tests conducted with satisfactory results. VSP (3b)

The Sodium-Carbonate Process for Treating Cast Iron. E. W. Colbeck & N. L. Evans. *Foundry Trade Journal*, Vol. 49, Oct. 5, 1934, pages 191-192. Hitherto it has been usual to treat cast iron to remove sulphur from it by placing sodium carbonate at the bottom of the ladle into which the iron is to be poured. This is satisfactory when heavy castings are being dealt with, but where small batches of metal are being treated in the ladle, the time which must be allowed for the thickening and removal of the soda slag is sufficiently long to cause the metal to fall to such a temperature that castings cannot be satisfactorily poured. To overcome this difficulty sodium carbonate is now being put on the market in the form of fused blocks which can be added to the cupola with the rest of the charge. It has been found that when a mixture of sodium carbonate and ground limestone has been used in the cupola, the reduction in sulphur is considerable but not quite so great as when sodium carbonate alone is used. Such a mixture, however, has a very satisfactory refining action on the graphite. The fluidity of the iron is better than that of the untreated metal. De-slagging can take place immediately tapping is finished so that there is considerable saving in time as compared with the standard ladle method of treatment. This results in a higher pouring temperature. Treatment with the mixture reduces the glare of the sodium flame, making it easier to see when the ladle is full. On account of the less violent agitation it produces, the mixture might be expected to be slightly less efficient as a degasifier than pure sodium carbonate, but no evidence to support this view is forthcoming. The mixture keeps the ladle very clean. It is recommended that the new method of treatment be used in place of the normal ladle treatment in the manufacture of small castings from ladles of 5-10 cwt. capacity, in mass production foundries where the thickening and removal of the slag would delay production, and when the time taken by the standard method would result in stiffening the metal as in casting low-P or low-Si mixtures. OWE (3b)

Making Malleable Iron in an Electric Furnace (Fabrication de la fonte malléable au four électriques). Marcel Guédras. *Journal du Four Electrique*, Vol. 43, May 1934, pages 171-173. Careful control of C, Mn and Si in malleable iron made in an electric furnace and annealing castings made from it for 6 to 12 hours in an electric annealing furnace would produce perfect black heart castings. JDG (3b)

Light Castings for Enamelling. H. B. McNair. *Foundry Trade Journal*, Vol. 50, Mar. 1, 1934, pages 148-151. McNair points out that light castings for enamelling must be free from distortion or breakage during the enamelling process and from surface defects or inclusions likely to interfere with the application of the enamel or the properties of the finished product. He then discusses methods whereby castings of this type may be produced, dealing with cupola control and materials used, discussing in passing the soda ash treatment of cast iron, and treating also of molding sand, facings, coal dust, and gating and pouring. OWE (3b)

Notes on Foundry Sands and Facings. F. A. W. Livermore. *Metal Industry*, London, Vol. 44, Apr. 13, 1934, pages 387-390. While foundry equipment, in general, has been improved and modernized, until recently, little progress has been made in a study of molding sand and its preparation. A large part of the data obtained by scientific investigation has not been correlated so that the practical man can utilize it in solving his daily problems. The author discusses sand under the following headings: (1 molding, (2) core, (3) parting and (4) facing sands. Under (1) analyses of three commonly used sands are listed. The essential requirements of a molding sand are permeability and porosity, refractoriness, cohesiveness, and durability. These are briefly described and the factors that influence them pointed out. (2) The functions and requirements of cores are mentioned and bonding materials for cores are divided into three classes: (a) sands bonded with clay and natural organic compounds; (b) sands bonded with water-soluble compounds; and (c) sands bonded with oil. Examples of each class and reasons for using them are cited. (3) The function of parting sand and its purpose, together with a typical chemical analysis are given. (4) A good surface on a casting can be most readily obtained if a good, well-prepared facing sand is used immediately on the pattern. It is best obtained by mixing old and new sand, generally with the addition of coal dust, plumbago, terra-flake or flour. Milling by a machine is superior to hand-mixing. A table giving the proportions of coal dust to sand for various thicknesses of casting are included. Frequently the face of the mold is dusted, sprayed, "sleeked" or washed with plumbago as a powder or in paint form. Old foundry crucibles, ground in a pan mill and mixed with water or clay water may be used as facing paint. HBG (3b)

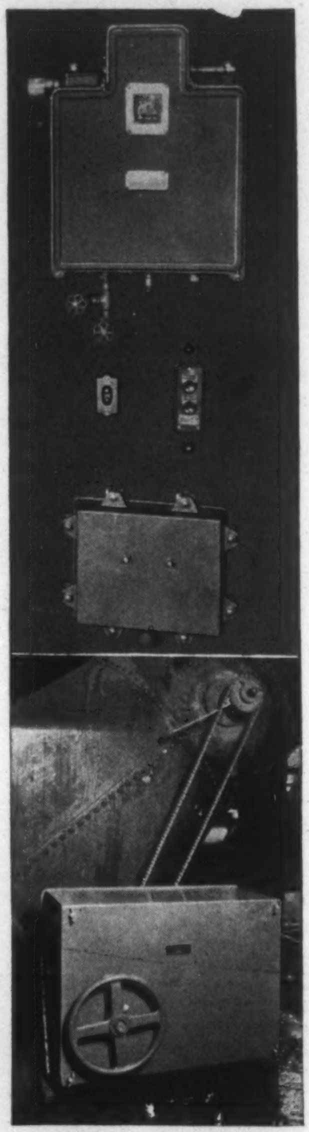
Pipe Foundry in Lugansk. A. I. Lobatch-Zhuchenko. *Domez*, 1934, No. 2-3, pages 47-62. (In Russian.) Description of the proposed cast iron pipe foundry. (3b)

Recent Progress in Knowledge of Fundamentals of Making of Steel (Neuere Fortschritte in der Erkenntnis der Grundlagen der Stahlerzeugung). Em. Lubojatzky. *Montanistische Rundschau*, Vol. 26, July 1, 1934, pages 1-4. A theoretical discussion of the reactions involved in the oxidation of C, Mn, Si, and P in steel according to the law of mass reaction, taking into consideration the basicity of the slag and the reaction temperature according to the van't Hoff formula for the relation between heat and equilibrium constants. BHS (3b)

New Foundry Machines (Neue Giessereimaschinen). H. Kalpers. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, Apr. 29, 1934, pages 248-250; May 6, 1934, pages 258-259. Author describes (1) sand dressing machines as made by A. Stotz, Stuttgart and Badische Maschinenfabrik, Durlach, (2) molding machines as made by Heinrich Herring Sons, Milspe, Hartung Co., Berlin-Lichtenberg, Giesserei- & Werkzeugmaschinenfabrik Franfurt'/Main and (3) machines for cleaning castings. GN (3b)

The Influence of Non-Metallic Nuclei on Graphite Formation in Cast Iron. Heredity Effects in Cast Iron and their Causes (Der Einfluss nichtmetallischer Keime auf die Graphitausbildung im Gusseisen. Vererbungserscheinungen im Gusseisen und deren Ursachen). O. v. Keil, R. Mitsche, A. Legat & H. Trenkler. *Archiv für das Eisenhüttenwesen*, Vol. 7, April 1934, pages 579-584. In laboratory and large scale melts of cast iron the manner of solidification of the graphite appeared to be greatly influenced by the presence of finely divided silicate inclusions. Reducing or melting conditions in pig or cast iron which caused silicates to be absent favored the formation of finely divided graphite. In charcoal iron no silicates are formed, and this would account for the more finely divided graphite and hence superiority of charcoal iron. SE (3b)

Reactions of Manganese, Silicon, and Carbon in Steel Making—Laboratory and Plant Research (Das Verhalten von Mangan, Silizium und Kohlenstoff bei der Stahlerzeugung, Laboratoriumsforschung und Betriebsversuche). F. Körber. *Stahl und Eisen*, Vol. 54, May 1934, pages 535-543. The latest of a series by the Kaiser-Wilhelm-Institut für Eisenforschung on the chemistry of steel making. To arrive at the equilibria between molten $\mathrm{Fe\text{-}FeO\text{-}MnO\text{-}SiO_2}$ and solid SiO_2, the equilibria between Fe, Mn, and Si and their oxides were determined in C-free melts. The equilibria throw light on the deoxidation of molten Fe with Mn and Si and on the composition and form of the deoxidation products. The effect of C on the reactions was studied in laboratory melts and in the acid open-hearth. The attainment of fluid deoxidation products, effect of slag viscosity, and of C in a quiet and in an active bath, are discussed. SE (3b)



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Origin of Sulphur in Cast Iron (Les Origines du Soufre dans la Fonte). Marcel Olinger. *La Fonte,* Vol. 11, Jan.-Feb.-Mar. 1934, pages 391-397. CaO and Mn tend to reduce the S content in the blast furnace. SiO_2FeO will react with MnS and give up S to the Fe. During pouring, MnS and O_2 react to give off SO_2. In the basic electric furnace ideal conditions may be produced for desulphurization. In the cupola, reduction of S content is very difficult, due to oxidizing atmosphere and lower metal temperatures. Most of the S removed in the cupola is costly in Mn. Hot, fluid slags are necessary. Walter briquettes, consisting of alkali and alkaline-earth salts; leucite, a double silicate of Al and K; and anhydrous Na_2CO_3 are useful as desulphurizers. Volumetric, gravimetric and electric furnace determinations of S are given. WHS (3b)

Duplexing of Malleable Cast Iron. Charles Morrison. *Iron Age,* Vol. 133, June 7, 1934, pages 19, 76, 78, 80, 82; *Foundry,* Vol. 62, June 1934, pages 25-26, 46. Describes present practice of duplexing malleable cast Fe at plant of General Motors Corp., Saginaw, Mich. Melting is done in 4-102 in. diam. cupolas. They are lined to 72 in. at melting zone and have a capacity of 28 tons per hr. Charging is done by hand and charge consists of sprue silvery pig Fe, and steel rails and pressed steel bundles. Typical analysis of Fe is: C—2.70%, Si—1.50, Mn—0.40, P—0.060, S—0.140. Fused Na_2CO_3 is used to reduce S and refine metal. About 1.00% C is absorbed from coke. Temperature of Fe at spout is about 2800° F. 2 electric furnaces are used for superheating. Each furnace has a capacity of 4 tons cold melt and 32 tons duplexing. Fe is tapped at 2850° F. Analysis of electric furnace Fe is: C—2.70%, Si—1.10, Mn—0.40, P—0.060, S—0.110. Energy consumption on furnace run is about 48 to 55 Kw.h./ton of Fe on 25 ton/hr. production rate per furnace. Fe made by duplexing has tensile strength of 48,000 to 52,000 lbs./in.^{2}, a yield point of 33,000 to 37,000 lbs./in.^{2} and elongation of about 15%. VSP (3b)

Segregation in Steel Ingots (Die Seigerung in Stahlblöcken). H. Meyer. *Stahl und Eisen,* Vol. 54, June 7, 1934, pages 597-605. Deep etch tests and analyses through sections of 3 and 5-ton ingots of effervescent semi-killed, and killed steel are shown. Evolution of CO during solidification is the main cause of segregation and it can be reduced by deoxidizing additions. However, for some purposes an effervescing, i.e., a segregated ingot may be preferable. SE (3b)

Desulphurization of Steel Baths with Fluorspar (Die Entschwefelung von Stahlbädern durch Flusspat). O. Meyer & J. Görissen. *Archiv für das Eisenhüttenwesen,* Vol. 7, June 1934, pages 665-672. It is shown that adding fluorspar to the slag improves desulphurization not through the formation of volatile S-F compounds, but through the increased fluidity and basicity of the slag. The more fluid slag is more active in oxidizing S to SO_2; it is shown that such oxidation can occur even in the presence of a reducing $CO\text{-}CO_2$ atmosphere. The formation of SiF_4 in acid and basic furnaces which would aid desulphurization by increasing the basicity of the slag is indicated. Practically, however, this reaction is not significant. The chemical reactions accounting for the greater furnace erosion when using fluorspar are described. SE (3b)

The Behaviour of Sulphur in Open-hearth Furnace Gases. E. Maurer & W. Bischof. *Iron & Steel Institute, Advance Copy* No. 11, May 1934, 21 pages. The reactions $FeS + H_2 \leftrightarrows Fe + H_2S$ and $FeS + O_2 \leftrightarrows Fe + SO_2$ were studied by heating steel in contact with mixtures of H_2S and H_2 or SO_2 and O_2. Equilibrium was not obtained because the refractories would not last long enough, but the change in S content of the gas was determined and the ratios at which it would be constant were estimated. For steels containing below 1% S there is a direct proportionality between the ratio H_2S/H_2 and the S content of steel and between SO_2/O_2 and the S content of steel. Analysis of data from actual open-hearth operation proved that the reaction $FeS + O_2 \leftrightarrows Fe + SO_2$ governs the distribution of S. In applying the results the composition of the waste gas should be used. The influence of different compositions of fuel gas on the S relationship is discussed. 6 references. JLG (3b)

The Distribution of Sulphur between Gas and Molten Iron (Die Verteilung des Schwefels zwischen Gas und flüssigem Eisen). E. Maurer & F. Bischof. *Archiv für das Eisenhüttenwesen,* Vol. 7, June 1934, pages 655-663. The equilibrium constants for the reactions $FeS + H_2 \leftrightarrows Fe + H_2S$ and $FeS + O_2 \leftrightarrows Fe + SO_2$ and their variation with temperature up to 1475° C. were determined, on introducing up to 30% S into molten iron. The results for the reaction with SO_2 agreed well with the S pickup from SO_2 containing gases observed in the open-hearth. SE (3b)

The Manufacture of High Quality Cast Iron in the Rotary Pulverized-Fuel Furnace. P. M. Macnair. *Transactions of the Institution of Engineers and Shipbuilders in Scotland,* Vol. 76, 1933, pages 356-389. Includes discussion. The construction and operation of rotating pulverized-fuel melting furnaces are described, and economic considerations discussed. Close control of composition, ease of attaining superheat, and elimination (on account of the steady rotation of the furnace) of oxides and slag are claimed. In high quality iron, the graphite should be distributed in fine particles. The rotating furnace will produce such iron from a wide variety of charges and scrap mixtures by melting these rapidly to a high temperature so as to take all coarse carbon nuclei into solution. JCC (3b)

Quantity of Air, Coke Charged and Output in the Cupola (Windmenge, Kokssatz und Schmeltzleistung bei Kupolöfen). H. Jungbluth & A. Heller. *Technische Mitteilungen Krupp,* No. 4, Dec. 1933, pages 99-105. See *Metals & Alloys,* Vol. 5, May 1934, page MA 180. Ha (3b)

Studies on the Viscosity of Iron and Steel Slags (Untersuchungen über die Viskosität der Eisenhüttenschlacken). F. Hartmann. *Stahl und Eisen,* Vol. 54, May 31, 1934, pages 564-572. The viscosity was determined by Margules' turning method. The melting point of the slag gave no indication of the viscosity-temperature curve. "Long" and "short" blast furnace slags differed only little in viscosity, from 2.5 to 2 g./cm./sec. In open-hearth slags the viscosity was not always lowered by higher lime content. Bauxite lowered the viscosity only little, fluorspar lowered it decidedly. Alkalies lowered, and Ba, Sr, Ca, and Mg oxides, raised the viscosity. Less viscous mixer slags give better desulphurization but also more furnace wall erosion. The viscosity of slags increases in the following order: mixer, blast-furnace, open-hearth, basic bessemer. SE (3b)

Ingots for Forgings. J. H. Hruska. *Heat Treating & Forging,* Vol. 20, May 1934, pages 219-221. Includes bibliography of 10 references. Discusses correct practice for making large ingots for forgings. MS (3b)

Finishing the Heat of Steel. Pt. XXI. J. H. Hruska. *Blast Furnace & Steel Plant,* Vol. 22, June 1934, pages 335-336. Deals with shrinkage of ingots. Measurements made on a 20-ton Ni-Cr steel ingot show that the transverse shrinkage in various parts of the ingot is not uniform. It depends upon many factors. The variation in shrinkage produces shear stresses, which may lead eventually to cracking. MS (3b)

Steel for Heat Treating and Forging. J. H. Hruska. *Heat Treating & Forging,* Vol. 20, June 1934, pages 275-278. Describes correct practice for making ingots of high-speed, austenitic Mn, carburizing, stainless and Ni steels. MS (3b)

Mass Effort and Quality in Steel Making. John H. Hruska. *Iron Age,* Vol. 133, Apr. 12, 1934, pages 14-15, 76. Discusses mass effect in steel making processes and states that the quality of product should be considered in relation to hearth design. Suggests a "reaction ratio," $\dfrac{\text{Bath area in sq. in (A)}}{\text{Wt. of metal in lb. (wt.)}}$ Degasification and deoxidation is faster in furnaces of high reaction ratios. Structure of resulting metal is uniform. Includes table showing characteristics of heats made in various steel making processes. VSP (3b)

Castings Development Discussed at Cleveland. *Iron Age,* Vol. 133, Feb. 8, 1934, pages 41 H-41 I. Progress in development and application of gray Fe, malleable and steel castings and physical properties was discussed at a joint meeting by Harry A. Schwartz, Fred J. Walls & R. A. Bull. VSP (3b)

Indirect Rapid Determination of Ferrous Oxide Dissolved in Liquid Open-Hearth Steel (Verfahren zur indirekten Schnellbestimmung des im flüssigen Siemens-Martin-Stahl gelösten Eisenoxyduls). H. Schenck. *Technische Mitteilungen Krupp,* No. 4, Dec. 1933, pages 118-120. See *Metals & Alloys,* Vol. 5, June 1934, page MA 253. Ha (3b)

Molding and Casting of the Main Frames of Grass Mowing Machines (Formen und Giessen der Hauptrahmen für Grassmähmaschinen). W. Schneider. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, May 13, 1934, pages 197-199. Whereas the main frames of grass mowing machines were formerly molded manually they are now made on special molding machines. Frames are cast in horizontal position. GN (3b)

The Effect of Fluorspar on the Viscosity of Basic Slags. Lenher Schwerin. *Metals & Alloys,* Vol. 5, June 1934, pages 118-123. Investigation leads to conclusions that addition of fluorspar to basic slags has an effect analogous to increasing temperature, viscosity effect is more pronounced at lower temperatures, at given temperature effect is proportional to addition, decreased viscosity is not a temporary effect but lasts for 1-2 hrs., presence of silica in spar does not decrease its efficiency up to 16.7% SiO_2. 13 references. WLC (3b)

Manufacture of Rimmed Steel Ingots. J. H. Nead & T. S. Washburn. *Metals & Alloys,* Vol. 5, Mar. 1934, pages 43-47. Rimmed steel ingots used for the production of deep drawing sheet are discussed with the factor affecting their quality. WLC (3b)

Working of an 150-ton Open Hearth Furnace According to the Experience of Kouznetzk Plant. G. F. Pishtshalko. *Domez,* No. 1, 1934, pages 5-12 (In Russian.) Open hearth practice used at this plant is given by describing in detail the making of a heat. Teeming is done at the rate of more than 5 tons per minute. (3b)

Eutectic Solidification of Cast Iron (L'Importance des Processus de Solidification Eutectique sur les Propriétés de la Fonte). E. Piwowarsky. *Bulletin de l'Association Technique de Fonderie,* Vol. 8, Mar. 1934, pages 96-105. Any metallurgical treatment which, for the same mechanical composition, affects the matrix and properties of the cast iron, acts by a displacement of the eutectic arrest point in the solidification of the metal. Superheating the metal lowers the eutectic solidification point. Increasing Si content raises the eutectic point if the addition is made early enough, but lowers it if made just before the metal is poured. An addition of Mn, made just before pouring acts in the same manner as the late Si, addition. The mechanics and speed of solution of graphite in cast iron at different temperatures are treated in detail. Relatively high coke to iron ratios are necessary in melting high carbon charges. 9 references. WHS (3b)

The Rate of Solution of Graphite in Molten Iron (Die Auflösungsgeschwindigkeit des Graphits in flüssigen Eisen). E. Piwowarsky. *Archiv für das Eisenhüttenwesen,* Vol. 7, Jan. 1934, pages 431-432. Time-temperature curves of different cast irons showed that even at very rapid heating rates the graphite goes into solution in the melt in a narrow temperature range. Coarse graphite flakes went into solution in only a few seconds at 1200 to 1400° C. This would indicate that the effect of superheating is not due to more rapid solution of the graphite. SE (3b)

Duplex Refining Process. Albert Portevin. *Metal Progress,* Vol. 25, Feb. 1934, pages 41-42. The variables affecting the speed with which equilibrium can be reached in a steel making furnace are discussed. Temperature, composition and its relation to equilibrium composition, fluidity of metal and slag, size of contact surfaces and stirring action are some of these variables. Discussion leads to the conclusion that converter oxidation followed by deoxidation by the emulsion process with an appropriate slag is highly satisfactory. Emulsion process involves emulsification of the two phases by impact and was discussed in *Metal Progress,* Vol. 23, Feb. 1933. WLC (3b)

Wrought Iron and Gas Fuel. J. B. Nealey. *Heat Treating & Forging,* Vol. 20, June 1934, pages 288-290. Description of Aston process. MS (3b)

A Molding Unit for Mass Production. J. B. Nealey. *Iron Age,* Vol. 133, Jan. 25, 1934, pages 24-25, 68. Describes the production of cast Fe pipe from 1½ in. to 6 in. in diam. and 6 ft. long in permanent molds at plant of American Radiator Co. All operations are synchronized by means of loop conveyors. VSP (3b)

Solidification of Steel in Ingot Molds. L. H. Nelson. *Transactions American Society for Metals,* Vol. 22, Mar. 1934, pages 193-226. Reports determination of the rate of solidification in various cast iron ingot molds. Factors affecting solidification are stated as (1) type, shape and size of mold; (2) superheat in steel; (3) analysis as it affects heat conductivity of steel; and (4) temperature of mold. It is noted that molds tipped over 5-10 min. after pouring show solidified cross section closely following the contour of mold but after 20 min. or more cavity in square ingots is circular and in rectangular ingots elliptical. Solidification normal to surface of mold is usually not more than ⅛" deeper at bottom than top. Ingots tipped more than 20 min. after pouring show a mushy or porous steel adhering to the inside of the cavity due to slow transition from liquid to solid and is probably related to porosity found in ingots and suggests how jarring or moving ingots before complete solidification may cause porous zones or holes. The depth of transverse solidification is found to be proportional to square root of time for square and round ingots. The proportionality factor is characteristic of the ingot. Factors affecting transverse solidification are size of cross section, area of mold wall over area of ingot, and shape of cross section of mold. It is found that 10% increase in mold wall area will increase transverse solidification 2%. Mold wall area about 1.5-2.0 times ingot area is desirable. With same ratio of mold wall and ingot areas a rectangular ingot will solidify faster than square and square ingot faster than round or fluted. Longitudinal solidification depends upon size of section of ingot and amount of taper. Ingots of low ratio between length and width will slow up solidification at top preventing bridging. Ingot length 2-2.8 times width with taper 0.5"/ft. is suggested. Discussion. WLC (3b)

Dendritic Segregation in Steel Ingots. L. Northcott. *Iron & Steel Institute, Advance Copy* No. 14, May 1934, 7 pages. Chemical and macroscopic examination of a large steel ingot showed that dendritic structure is primarily due to P segregation. A sample obtained from the dendritic axis with a small drill contained 0.04% P while adjacent material contained 0.10% P. Heating in H, impure N, and caustic soda followed by macroscopic examination gave the same indication. Molten caustic soda removed P from steel, P-rich cast iron, and phosphor-Cu. JLG (3b)

A Study of Ingot Structures. L. Northcott. *Iron & Steel Institute, Advance Copy* No. 13, May 1934, 11 pages. A 20-ton ingot cast in a special mold with a bottom metal chill and refractory sides was sectioned and examined after etching with several reagents. Primary structure varied from equiaxed crystals to coarse dendrites. There was not a complete relationship between primary and secondary structure. The tertiary structure (ferrite and pearlite) was quite definitely inherited from the secondary structure. A layer of inclusions was found near the bottom of the ingot. Small Cu ingots were cast and their structures compared with that of the steel ingot. A columnar structure was formed from hot metal and not from cold metal irrespective of the mold temperature. A bottom-cast steel ingot was sectioned, etched, and the structures segregated and described. 12 references. JLG (3b)

Some Practical Considerations in a Small Jobbing Foundry. B. GALE. *Foundry Trade Journal,* Vol. 50, Nov. 16, 1933, pages 275-278. Deals with various difficulties met in the small jobbing foundry. Items considered are: material control, coke and foaming slags, molding sands, core sands and core-making, and molding and melting practice. OWE (3b)

Making Quality Steels. EMIL GATHMANN. *Blast Furnace & Steel Plant,* Vol. 22, June 1934, page 341. For obtaining highest yields of pipe-free ingots, it is important that shrink-head casings are not removed from big-end-up ingots until all of the steel is solid. MS (3b)

Chromium Additions to Cast Iron for Foundry Purposes. J. E. HURST. *Foundry Trade Journal,* Vol. 50, Feb. 15, 1934, pages 117-118. Hurst discusses the physical characteristics of the alloys of iron and chromium and of iron, chromium, and carbon, and then deals with the difficulties met in introducing chromium into melts. Article closes with a description of experiments on various methods of making chromium additions to cupola-melted cast irons, which show the variations in yield of chromium in the final metal when additions are made in various forms under constant plant conditions. The value of adding chromium in diluted form, either in the scrap or as alloy pig-irons, is clearly indicated. OWE (3b)

The Foundry of the Midland Electric Manufacturing Company, Limited—An Outstanding Example of Mechanization. VINCENT C. FAULKNER. *Foundry Trade Journal,* Vol. 49, Dec. 14, 1933, pages 341-343, 348. Article, accompanied by 9 illustrations, describing the continuous-casting plant at the above works. OWE (3b)

Modern Foundry Practice. VINCENT C. FAULKNER. *Foundry Trade Journal,* Vol. 50, Mar. 29, 1934, page 215. Paper, illustrated by 3 photographs, dealing with mechanization of foundries. OWE (3b)

On the Manufacture of Rimming Steel. WILLIAM R. FLEMING. *Transactions American Society for Metals,* Vol. 22, June 1934, pages 532-546. Rimmed ingot quality depends upon the size and distribution of blowholes and author describes 4 classes of ingot, (1) metal which neither rises nor sinks until flat rim has frozen across several inches wide when a gradual sinking occurs leaving a slight depression in center when solid, (2) freezes similarly until a well 3-5 in. in dia. in center stops and becomes mushy then builds up a "nigger head," (3) metal rises gradually in the mold from the finish of teeming increasing in volume as much as 1 cu. ft. at times, (4) freezes straight across without depression of (1) or nigger head of (2). Ingots of type (3) are thin skinned and of very inferior quality. Other types will make fairly satisfactory sheet if properly croped and watched. Al is very useful in making rimmed ingot by skillful steel maker. It helps to hold down any rising action as do Si and Ti when properly handled. P and Mn additions must be compensated for or proper rimming will not take place. Author states that such steel making is an art and learned by cut and try. In discussion Ashdown calls attention to work of Herty and Iron and Steel Institute on heterogeneity of steel ingots as indicating that all is not cut and try. WLC (3b)

Molding Cast Iron Belt Pulleys. J. H. EASTHAM. *Iron Age,* Vol. 133, Jan. 25, 1934, pages 18-19, 68. Describes the open sand method of molding pulleys of large and small size. Recommends the method for its flexibility and savings it effects. VSP (3b)

Simplify Casting of V-8 Cylinder. PAT DWYER. *Foundry,* Vol. 62, May 1934, pages 14-17, 52. Describes methods employed in production of V-8 automobile cylinder blocks at the plant of the Ford Motor Co. Predetermined production pace is set by moving mechanical equipment. Fe for cylinders has the following approximate analysis: Si 1.80 to 2.10%; S 0.10% maximum; P 0.25 to 0 32%; Mn 0.60 to 0.80%; total C 3.20 to 3.50%. The Fe is a mixture of cupola melted Fe, and direct metal from blast furnace. Risers are eliminated on castings. Molds for cylinder blocks are made in cast steel flasks with gaps in sides of drags and corresponding projections on sides of copes. Thin strips of steel are laid upon mold surface before core is lowered to facilitate setting the barrel core assemblies and prevent core from scraping slanted skin dried surface of mold. VSP (3b)

Making Tool Steel Where Taylor, White Experimented. EDWIN F. CONE. *Steel,* Vol. 94, June 18, 1934, pages 51-52, 54. Outlines the development and some of the features of the tool-steel department of the Bethlehem Steel Co., Bethlehem, Pa. Equipment includes a 14-lb., two 600-lb., and two 1200-lb. high-frequency induction furnaces; a 500-lb., a 3-ton, and a 6-ton arc furnace; a 14,000 lb. hammer for cogging ingots; 5 other hammers ranging from 500 to 4500 lbs.; 2 rolling mills; 2 gas and 5 electric heat treating furnaces; and finishing and pickling equipment. MS (3b)

Problems in Woodworking Machinery Castings. ROBERT BALLANTINE. *Foundry Trade Journal,* Vol. 50, Feb. 15, 1934, pages 113-115. Article accompanied by 6 diagrams, dealing with castings used in constructing woodworking machinery. Four examples of castings are chosen for study, the first an example of unorthodox method of production, the second an example of mass production castings, the third a case where author objected to design alterations to a casting pattern, and the fourth an old type of pattern made 2 in a box to cheapen production cost, and which ought to be redesigned for further economies. OWE (3b)

Mechanization of Foundries. A. W. G. BAGSHAWE. *Foundry Trade Journal,* Vol. 50, Jan. 18, 1934, pages 51-52. Bagshawe discusses in a general way the changes which have occurred during 1933. Special attention is directed to a new type of conveyor for handling spare molten iron left in the ladles and delivering it in the form of pigs to the charging platform for remelting. OWE (3b)

Metallurgy of Crucible Melting (Zur Metallurgie des Tiegelschmelzverfahrens). P. BARDENHEUER & W. BOTTENBERG. *Archiv für das Eisenhüttenwesen,* Vol. 7, May 1934, pages 595-598. 300 Kg. melts of 1.4% C, 0.03% Si, 0.10% Mn steel were melted in silica crucibles in a coreless induction furnace and the "crucible reactions" studied. According to these reactions silica from the crucible is reduced by the C and Fe in the melt, the reduced Si being absorbed by the melt. The FeO formed reacts with the C so that the latter is eliminated as CO. Reduction of silica and the accompanying C elimination increased rapidly with temperature; at 1400° C. the rate was about 0.001% per minute, at 1650° C. it was about 0.006% per minute. SE (3b)

Foundry Mechanization. A. S. BEECH. *Foundry Trade Journal,* Vol. 50, Jan. 4, 1934, pages 7-10. Beech divides mechanized plants into 3 groups—semi-mechanized or intermittent; fully continuous; high production, specialized continuous; and discusses each at considerable length. OWE (3b)

Makes High Silicon Iron Castings. EDWIN BREMER. *Foundry,* Vol. 62, Mar. 1934, pages 12-14, 40. Describes plant of Duriron Co., Dayton. Gives composition of high Si acid resisting castings. Outlines method of furnace construction; molding and coremaking. VSP (3b)

Spins Molds After Pouring Alloy Steel Castings. EDWIN BREMER. *Steel,* Vol. 94, June 11, 1934, pages 54, 56. For certain castings made by the Duriron Co., Dayton, O., molds are placed on a table and are filled while stationary, after which table is rotated at about 50 r.p.m. for 5-6 min. Gate sides of the molds form the inner circle. Centrifugal method is employed for castings in which a side or end gate is used. MS (3b)

Experimental heats of commercially pure iron in the basic open hearth furnace. V. MOZHAROV, M. GERSHGORN & A. PROKHOROV. *Stal,* Vol. 4, Jan. 1934, pages 63-73. In Russian. Commercially pure iron was produced in a 20 ton furnace using scrap containing 0.04% S. Only Al was used for deoxidation. By skimming the slag twice, Mn was reduced to 0.03-0.04% and S to 0.02%. Other impurities gave no difficulties. HWR (3b)

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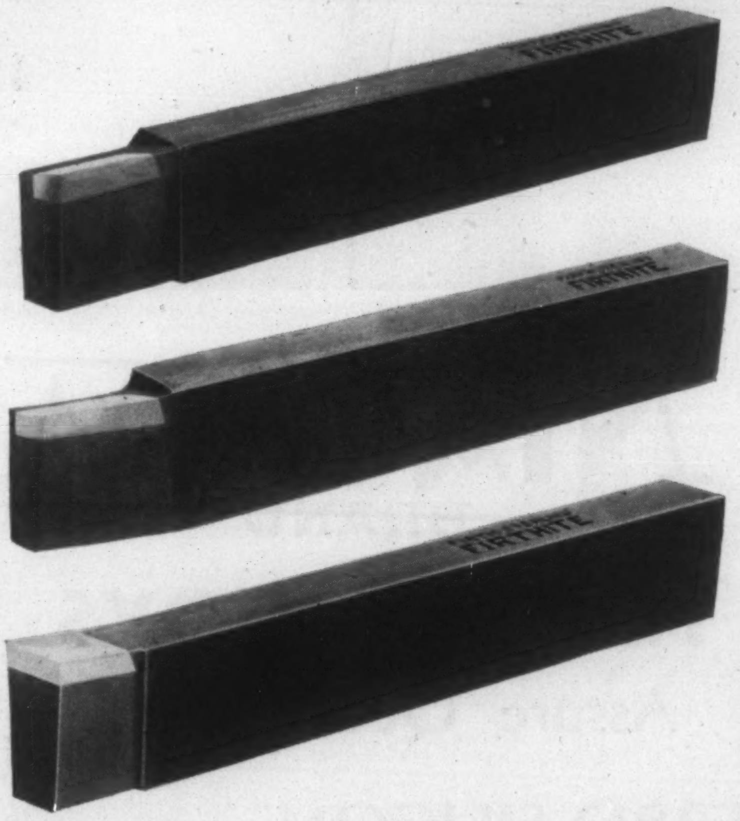

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WORKING OF METALS & ALLOYS (4)

Machining (4d)

H. W. GRAHAM, SECTION EDITOR

Soluble Oils in Machining of Metals (L'Huile soluble dans l'Usinage des Métaux) R. Bichet. *Usine,* Vol. 43, Mar. 15, 1934, page 34. Properties of soluble oils and best practice for using them in machining operations are compiled; rain water is best for using with these oils; ordinary water should have all calcium parts removed. Water and oil should first be mixed in equal proportion and then further water added as required. The workman should protect his skin well from the solution by a powder as often skin affections are caused. Ha (4d)

Suitable Temperature for the Machine Shop. M. H. Ball. *American Machinist,* Vol. 77, Nov. 8, 1933, page 724. Attention is called to the effect which the temperature of the shop can have on the work if expansion of metals is not taken into account. Especially interchangeability of parts might be endangered by not considering temperature effect on gages. Ha (4d)

Clamping Fixtures for Aluminum Plates and Covers. L. Francis Ayland. *Machinery,* London, Vol. 43, Feb. 22, 1934, page 618. Illustrated discussion of fixtures pointing out the advantages of a method of clamping thin Al plates for surface milling. Kz (4d)

Developments in Machine Tools (Allgemeine Entwicklungsgedanken im Werkzeugmaschinenbau) *Die Eisenbahn Werkstätte,* Vol. 41, Aug. 20, 1933, pages 138-139; Sept. 5, 1933, pages 148-149. New features incorporated in grinding, milling, planing, drilling machines and lathes exhibited at the Werkzeugmaschinenschau at the Leipzig Fair are discussed. WH (4d)

Roll Cambering Devices. R. C. Lewis. *Iron Age,* Vol. 132, Aug. 3, 1933, pages 18-23. Describes the features, advantages and limitations of some of the devices used for shaping rolls. Shows that present eccentric type of cambering device will produce the correct shapes for crown and concave rolls. Correct shapes are indicated as the elastic curve of a uniformly loaded beam for crown rolls and the curve true to a straight edge cross for concave rolls. It is of importance that the eccentric curve varies with angle of rotation affording an opportunity to deviate slightly from theoretical shape to compensate for local or special conditions. VSP (4d)

Connecting Rod Bores Finished to High Accuracy by New Method. John E. Kline. *Iron Age,* Vol. 133, April 5, 1934, pages 29, 71. Describes new method developed by Hutto Engineering Co., Detroit for large and small lot honing of connecting rod crankpin bores, straight, round and true to precise limits. Each rod is honed individually. Fixtures for use with hone may be operated easily and quickly. VSP (4d)

60 Minute Test Period as Standard for Rough-Turning (Die 60 min.- Standzeit als Richtwert beim Schruppdrehen). A. Wallichs and H. Schoepke. *Zeitschrift Verein deutscher Ingenieure,* Vol. 78, Mar. 3, 1934, pages 278-281. As basis of comparison for capacity and efficiency in chipping and turning processes a reduction to 60 min. of all stages required to do a given work is recommended. A set of formulas to calculate this preferred standard is given, an example illustrates the method. 12 references. Ha (4d)

Experiments on the Cutting Angle of Lathe Tools. Shizuo Dor. *Journal Society of Mechanical Engineers,* Vol. 36, Nov. 1933, pages 767-773. Paper read before the 238th Meeting of the Society of Mechanical Engineers, July 28, 1933. Experiments to determine the most economical shape of tool tips. Advantages of the Klopstock lathe are pointed out. Kz (4d)

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HEAT TREATMENT (5)

O. E. HARDER, SECTION EDITOR

Hardening, Quenching & Drawing (5b)

Salts for Steel Hardening Baths (Salze in der Stahlhärterei) Fr. Kirchdorfer. *Seifensieder Zeitung,* Vol. 60, Aug. 23, 1933, pages 619-620. Hints on preparation of hardening and drawing baths made up by salt mixtures, data on melting points of various salts and salt mixtures, additions of salts to quenching baths. EF (5b)

The Question of Temper Brittleness (Zur Frage der Anlasssprödigkeit) E. Houdremont & H. Schrader. *Technische Mitteilungen Krupp,* No. 1, Feb. 1934, pages 13-19. Temper brittleness is defined as deterioration of notch-toughness which occurs after hardening and drawing of steels if they are cooled slowly, for instance in the furnace. A report on this phenomenon by the Materials Committee of the Verein deutscher Eisenhüttenleute considers also other conditions besides slow cooling which might be contributive and whether an alloying element is the cause or can prevent it. The literature on the subject is reviewed critically. Modifications of Fe or residual austenite do not explain the phenomenon fully, also formation of special carbides does not elucidate it. A precipitation of O, N or P may be of importance but nothing definite can at present be said. 24 references. See also *Metals & Alloys,* Vol. 5, Apr. 1934, page MA 133. Ha (5b)

Interrupted Hardening of Spring Wire. Hamilton Ferguson. *Metal Progress,* Vol. 23, Sept. 1933, pages 48, 50. Hardness obtained on specimens of carbon steel, C 0.84 by quenching from 1500°F. in a salt bath held at 450°F. and cooled in air are given as 834 Firth Hardometer. Same hardness obtained by quenching directly in cold oil. Steel of C 0.77 showed 512 Brinell when air cooled after salt bath quench regardless of time of holding in the salt, but 719 to 587 Firth when held 1 to 5 min. in the salt and cooled in water. This steel showed also 834 Firth when quenched directly in cold oil. WLC (5b)

Hardenability and Temper Stability of Steels with Difficultly Soluble Special Carbides, with Particular Consideration of Vanadium Steels (Härtbarkeit und Anlassbeständigkeit von Stahlen mit schwer löslichen Sonderkarbiden, mit besonderer Berücksichtigung der Vanadinstahle) H. Bennek, E. Houdremont & H. Schrader. *Technische Mitteilungen Krupp,* No. 1, Feb. 1934, pages 1-7. Possibilities to predict properties of Fe alloys from their constituent elements, which had been tried formerly, were further investigated, in particular in W- and V-steels with respect to the effect of the alloying elements on hardening and tempering where special carbides are formed. As C is bound to the resp. carbide, hardenability at the same hardening temperature is reduced in these 2 steels as compared with C-steels because most of the special carbides are more difficultly soluble than cementite; these steels are also very insensitive to overheating due to the crystallization-retarding effect of the special carbides. With increasing temperature the carbides dissolve more and more, the critical cooling velocity is reduced and uniform hardening becomes better. The special carbides are segregated from the α-solid solution only at higher temperatures and cause precipitation hardening which superposes itself to the reduction of hardness on account of the disintegration of martensite and causes a secondary increase of hardness between 500° and 600°. This precipitation of V is the reason of the higher cutting capacity and heat-resistance of properly heat-treated V-steels. Temper stability must be ascribed solely to precipitation hardening, quite particularly of the special carbides. This observation was confirmed also on alloy steels for structural purposes, although here notch-toughness decreased considerably on account of precipitation of V-carbide. Ha (5b)

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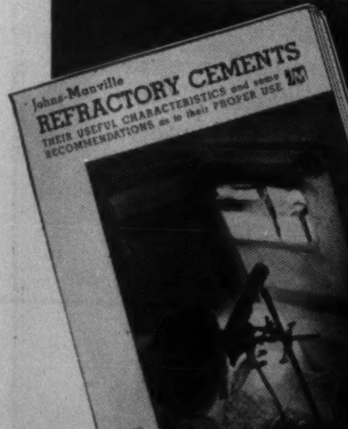
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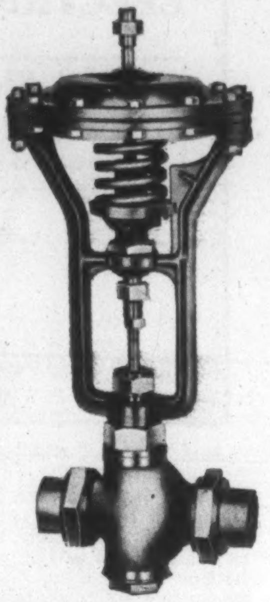

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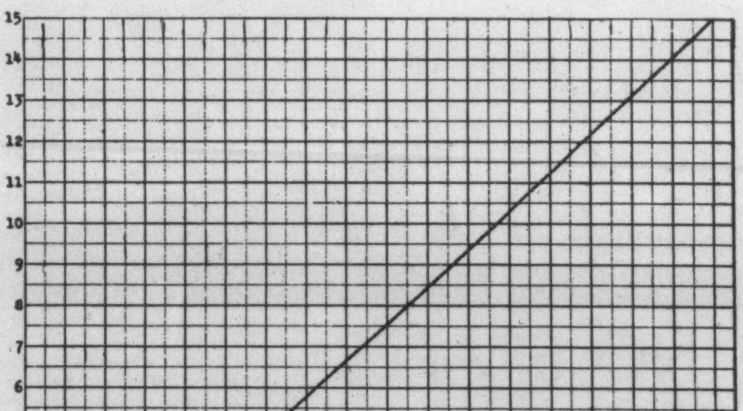

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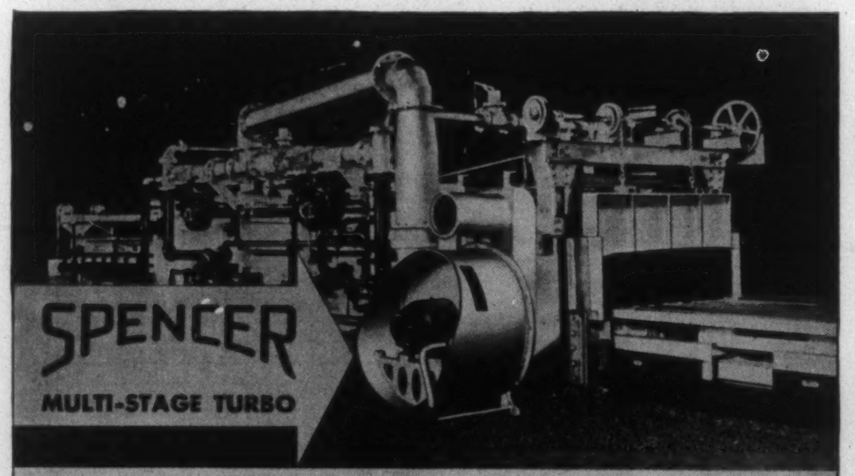
Heat Treatment of Alloy Tool Steel. J. C. ALEXANDER. *Mechanical World & Engineering Record,* Vol. 95, Mar. 16, 1934, pages 247-248. From the discussion are excluded C steels and high-speed steels. The heat treatment of alloy steels from which the various dies, press tools, shear blades, and cold punches are made is dealt with. Explanation of the effect of heat and the importance of observing certain soaking times to obtain the desired hardness and hardness penetration. If a cold piece of alloy steel is placed in a furnace registering a high temperature molecular segregation may occur which will develop into an open crack upon quenching. Alloy steels should be soaked for at least one hour per in. of thickness in a furnace adjusted to give a slightly carburizing atmosphere. Correctly hardened tools register a Rockwell hardness of 65-68 C. Temper immediately after hardening and allow ½ hour at least per in. of thickness at the tempering temperature. Also, as the alloy steels absorb the heat slowly, the stresses are relieved at a lower rate. Kz (5b)

The Selection and Care of Drill Steels, Bits, Shanks and Chucks. *Edgar Allen News,* Vol. 12, Mar. 1934, pages 406-408. A few examples of how maintenance of tools can be reduced by proper selection and treatment of steels. Ha (5b)

Hardening Instrument Pivots. W. H. LAWES. *Electrical Review,* Vol. 114, Apr. 13, 1934, pages 517-518. Furnace is made from a short piece of ½-in. quartz tube wound for ⅔ its length with a single layer of resistance wire. Means for regulating temperature from 700°-800° C. are provided. An adjustable H_2O pipe is arranged near the upper end of the tube. Steel wire is cut into lengths a little over double that of finished pivots with a 120° V-groove in the center. When tube is at red heat, steel pieces are placed in a 1-in. long tray of thin sheet nichrome or Fe, which is pushed to the middle of the tube. After pieces have soaked at hardening temperature for 1-2 min., H_2O is turned on, quenching the pivots and washing them into a gauze container. They are broken and tested for hardness, and other pieces are heated and quenched at other temperatures until the desired hardness is obtained. Grinding is done in 2 stages, care being taken not to heat the steel above 130° C. during the process. MS (5b)



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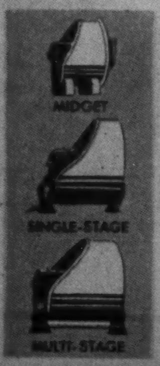

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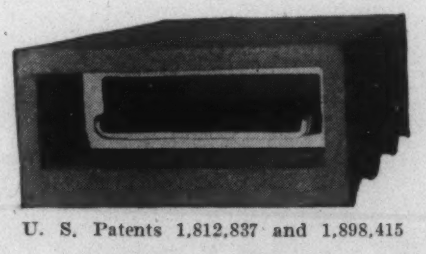
Aging (5c)

The Present Status of Age-Hardening. RICHARDS H. HARRINGTON. *Transactions American Society for Metals,* Vol. 22, June 1934, pages 505-531. Theoretical aspects of age-hardening are discussed as simple precipitation hardening, lattice distortion, and complications introduced by allotropy. Significance of temperature range between that for critical dispersion and solution as it affects the high temperature properties of age-hardened metal is discussed. Addition of Co to Fe-W alloy (15% Co, 12% W, 73% Fe) gives alloy with maximum age-hardness of 435 Brinell at 700° C. draw and tensile strength of 107,000 lbs./in.^{2} at 800° C. compared to 32,000 lbs./in.^{2} for alloy without Co. Alloy with matrix of high damping quality keyed with critically dispersed phase to resist deformation would make an excellent spring material. 2.6% Co, 0.4% Be in Cu produces such an alloy. Methods of survey of alloy field are discussed by two methods, addition of another element to promising binary alloys to produce such desirable results as red hardness, Co is an example of such element and Fe-Co-W alloys of such alloys. Ternary alloys may be rapidly surveyed by keeping two elements in constant ratio and adding third in various proportions. Ni-Fe-Ti alloys are discussed and some properties reported. Addition of Co to Ni-Be and Cu-Be alloys is discussed and aging characteristics given. Fuller examination of the properties other than hardness will be necessary before practical applications of some of these alloys can be proposed. Discussion by Sykes aging characteristics of Co-W alloys. WLC (5c)

Alloys for Carburizing Containers. EDWIN F. CONE. *American Machinist,* Vol. 78, July 4, 1934, pages 464-465. Sheet metal alloy "Rezistal No. 4" containing about 26% Ni, 18% Cr, and 2.5% Si is used as containers and boxes for parts to be carburized. Time of carburizing could be shortened with these containers. Ha (5c)



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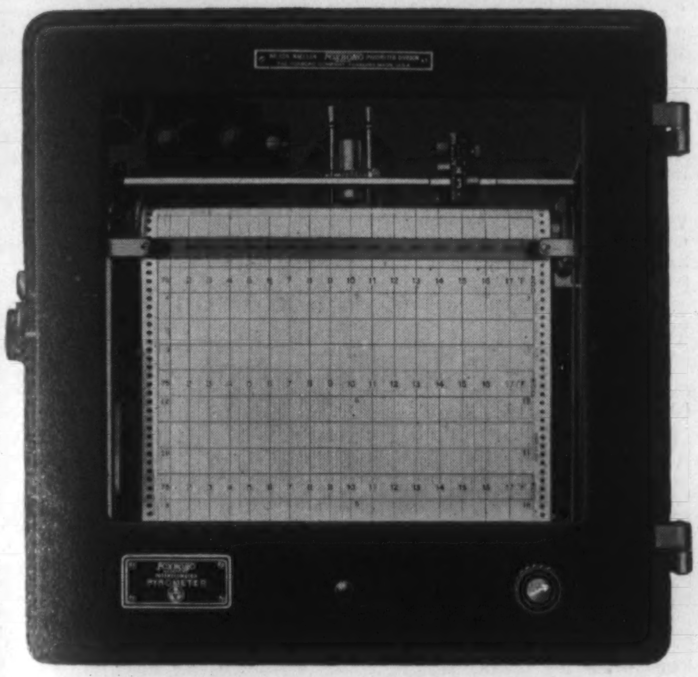

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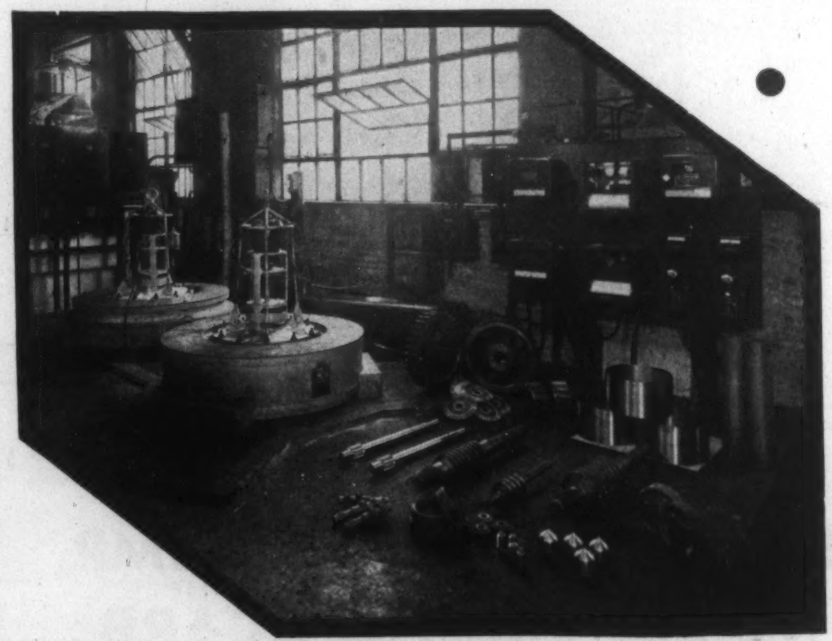

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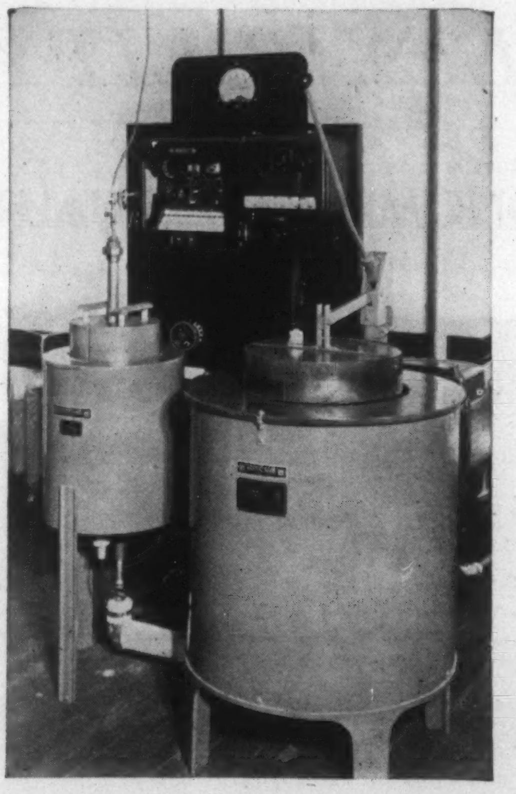

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FURNACES, REFRACTORIES & FUELS (6)

M. H. MAWHINNEY, SECTION EDITOR

Possibilities of Application of Heating by Induction without Iron Core (Die Verwendungsmöglichkeiten der Induktionsheizung ohne Eisenschluss) WILHELM FISCHER. *Elektrowärme,* Vol. 4, Apr. 1934, pages 77-82. The principle of heating a material in an induction furnace without iron core is explained and a nomogram is given from which the minimum frequency required for any material can be taken; the frequency must be the higher the lower the electric conductivity and the diam. of the material to be heated. Frequency lower than this minimum should not be used, as the efficiency of the furnace decreases rapidly with lower frequency. While up to 10,000 cycles generators can be used for producing the current, spark gaps are used for frequencies above 10,000 cycles per second. Advantages and applications in chemical industry, melting of metals, etc. are discussed; the highest temperature obtainable depends only on the heat losses, not taking into account the material of the crucible. The question of regulation of frequency is not so simple with spark generators as capacity and selfinduction of the circuit determine the frequency; tube generators are more flexible. 7 references. Ha (6)

Uses of Gas Diffusion Burner System in Forging Work. H. M. HEYN. *Iron Age.* Vol. 131, June 15, 1933, page 945, adv. sec. page 14. Discusses the advantages of using a diffusion combustion burner recently developed by Surface Combustion Corp'n, Toledo, Ohio, which has done much in advancing forge shop heating. When using diffusion combustion, the work being heated is enveloped in a blanket or layer of raw gas to protect it from oxidation. The burners can be automatically controlled or operated manually. Burners give flame lengths of 6 to 84 ft., although it is possible to project a flame of over 242 ft. in length. VSP (6)

Annealing of Wire. O. S. HASKELL. *Heat Treating & Forging,* Vol. 20, Feb. 1934, pages 94-96. General Electric Co. has developed an electric bell-type bright annealing furnace with multiple bases and retorts for the furnace loads. Fan is installed for circulating furnace atmosphere. After charge is loaded on base, retort is lowered over the charge and seals itself by means of a H_2O or oil seal in the base. Furnace atmosphere is admitted to the retort through permanent connections in the base. Furnace is lowered over the retort where it remains until the end of the heating cycle. Among the advantages are uniformity of anneal; use of any type of furnace atmosphere; ease of loading and unloading; simplicity of gas-tight seal; short heating and cooling cycles; low first cost, labor costs, and power requirements; flexibility in operation; and portability. Gives some test results for Cu wire. MS (6)

Electrical Furnaces in Industry (Die Bedeutung elektrischer öfen für die Industrie) H. KUNZE. *Elektrizitätswirtschaft,* Vol. 32, Aug. 25, 1933, pages 342-349. Paper before the General Meeting of the Vereinigung der Elektrizitätswerke. Essen, June 30, 1933. Advantages claimed: exact temperature control, possibility of securing different temperature regions simultaneously in the same work, absence of furnace gases and danger from flame, low waste (ratio 1 : 2 : 3 for electric furnace, coke, oil fired furnaces respectively), correct analysis of melts prepared in induction furnaces. Next the different types of electric furnaces employed in metallurgical industry are discussed and illustrated comprising induction furnace, annealing furnaces with circulated atmosphere. Air circulation is claimed to accelerate the heating-up speed 6 times (200° C.). Drying and low temperature furnaces incorporating heating coils according to Backer, medium temperature furnaces (1100° C. max.) with "Felgenheizelemente" or profiled heat resistant Cr-Ni strips (current load = 10 watt/cm.^{2}), Megapyr heat resistant material, representing a Cr-Al-Fe alloy with about 30% Cr, 5% Al for 1330° C. max. instead of Cr-Ni with 1100° C. max. (load = 2 watt/cm.^{2} at 1100° C.) and SiC for 1400° C. are the most important features covered. Special attention is called to a new giant electrode press of 1 million kg. weight recently built in Germany. The press runs at a working pressure of 10,000 ton for making electric furnace electrodes. EF (6)

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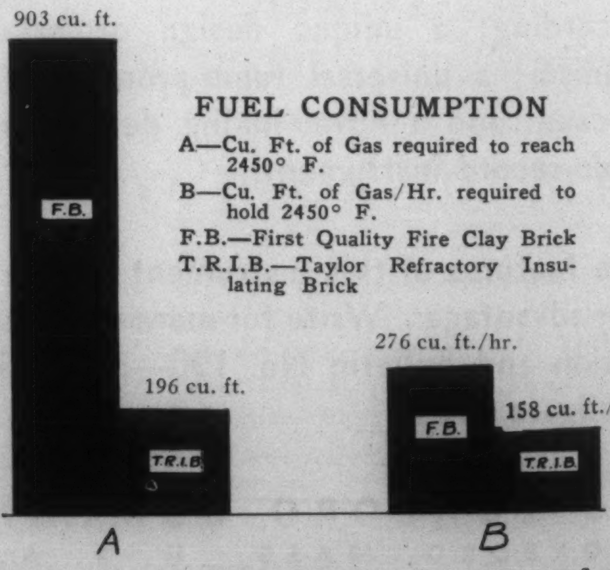

Chart drawn from data obtained on two gas-fired heat treating furnaces identical except for type of linings.

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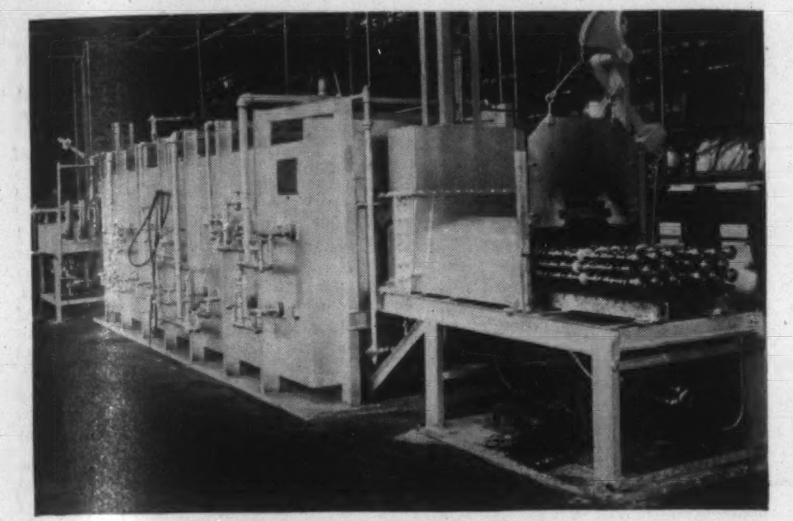

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*Quoted from publication of Surface Combustion Corp., Toledo, Ohio.

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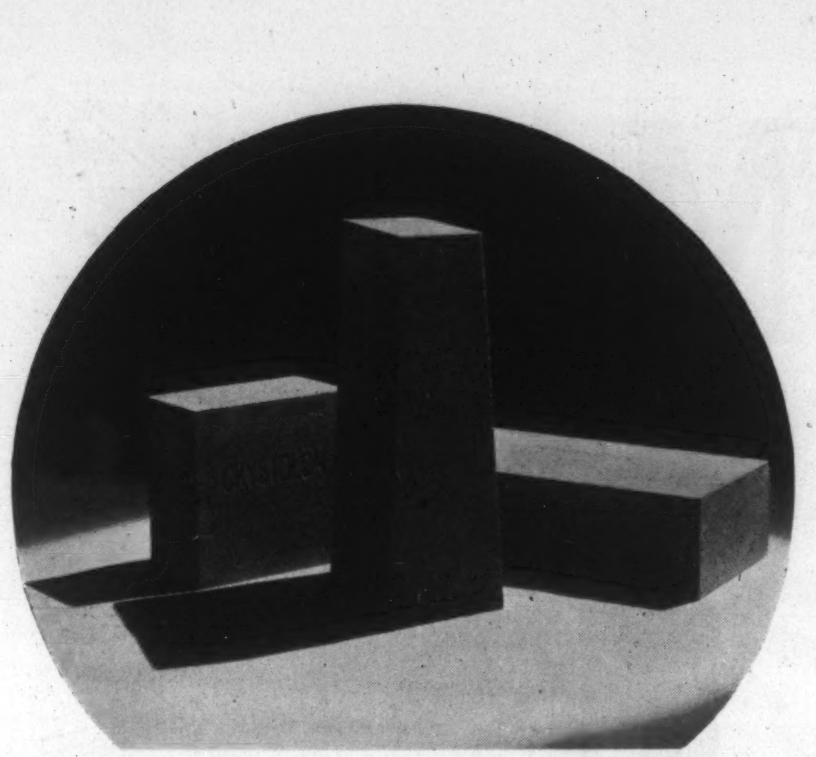

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NORTON
REFRACTORIES

Tendencies in the Development of Electric Furnaces (Entwicklungstendenzen im Bau elektrischer Industrieöfen). VICTOR PASCHKIS. *Elektrizitätswirtschaft*, Vol. 33, Jan. 31, 1934, pages 30-32. Points out new features noted on electric furnaces exhibited at the Elektrowärmeaustellung Essen. The tendencies in the development of induction furnaces are going in opposite directions, i.e. to smaller types in order to supply small shops with economic melting furnaces and to larger coreless induction furnaces of say 4-7.5 tons. High-frequency furnaces are making but little headway in Germany due to the high initial costs of frequency transformers. Resistance furnaces are greatly improved owing to the development of new metallic resistance materials. Cr-Al-Fe alloys withstand high temperatures. The maximum service temperature of Cr-Ni alloys has been raised from 1150° to 1250° C. For cyanide baths, metal crucibles and electrodes this alloy is now employed. Reactions between the salt bath and former chamotte linings are eliminated. The heat capacity of resistance furnaces has been reduced. Chamotte bricks have been widely replaced by materials of higher insulation ability. Circulation of furnace atmosphere, easy exchangeability of burnt-out resistance units, improved heat transmission, automatic furnace operation, introduction of noble metal thermo-couples of higher thermo-power and consequently cheaper instruments are stressed. WH (6)

An investigation of Some of the Refractories Used in Ladles and in Ingot Casting. Part I. Some Characteristics of the Clays Used in the Manufacture of Runners, Stoppers, Nozzles, etc. J. E. PRIESTLEY & W. J. REES. *Journal Society Chemical Industry*, Vol. 52, Sept. 22, 1933, pages 297T-304T. Read at joint meeting of the Yorkshire Section, Society Chemical Industry and the Refractories Association of Great Britain, Feb. 1933. An investigation was carried out on the physical characteristics at various firing temperatures of extruded runners and shapes which had been subjected to no after-treatment, and stamped sleeves that had not been plugged or extruded, but plug-and-flask moulded to give the product a dense texture with a smooth surface. Three kinds of clays were used. The investigation consisted in (a) the study of manufacturing details, analyses of the clays and products together with grading tests, etc., effect of moisture and (b) preparation of test pieces from undried material for contraction-on-firing data, specific gravity, porosity, reversible thermal expansion, underload refractoriness, cone refractoriness, etc. Besides firing the pieces experimentally, to note the change in the above properties, pieces were fired in a commercial firebrick kiln with a view of correlating laboratory firings and firing under works conditions. Considerable data is given in the form of curves and tables. VVK (6)

Dry-Quenched Coke for the Blast Furnace. J. FRANKLIN MILLER. *Iron Age*, Vol. 132, Aug. 24, 1933, pages 12-15. Describes equipment and methods used in Sulzer quenching process. Gives steam production data obtained on Sulzer plant at Rochester, N. Y., and points out advantages of the method. VSP (6)

High-Frequency Furnaces and Their Service to Industry—1923-1933. G. R. WEBSTER. *Foundry Trade Journal*, Vol. 49, Nov. 30, 1933, page 312. *See Metals & Alloys*, Vol. 5, May 1934, page MA 194. OWE (6)

Controlling Combustion in the Open-Hearth Furnace. H. J. WILLIAMS. *Iron Age*, Vol. 132, Sept. 21, 1933, pages 13-15. Most important feature of combustion control equipment is the proper proportioning of fuel and air. On natural gas fired open-hearth furnace, combustion control equipment will effect economies in fuel consumption by elimination of losses due to incomplete combustion or excess air. It will also result in faster working furnace which will further reduce fuel consumption and increase capacity of plant. When using natural gas the maintenance of proper air-gas ratio is a simple problem. Stresses importance of using pusher fan. Other points of importance are the proper control of stack draft and of temperature. VSP (6)

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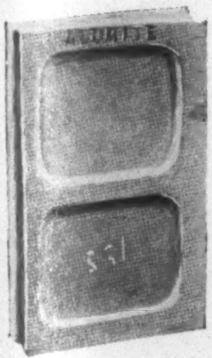

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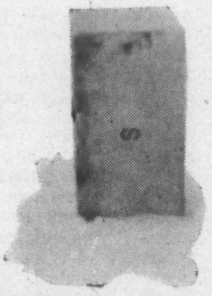

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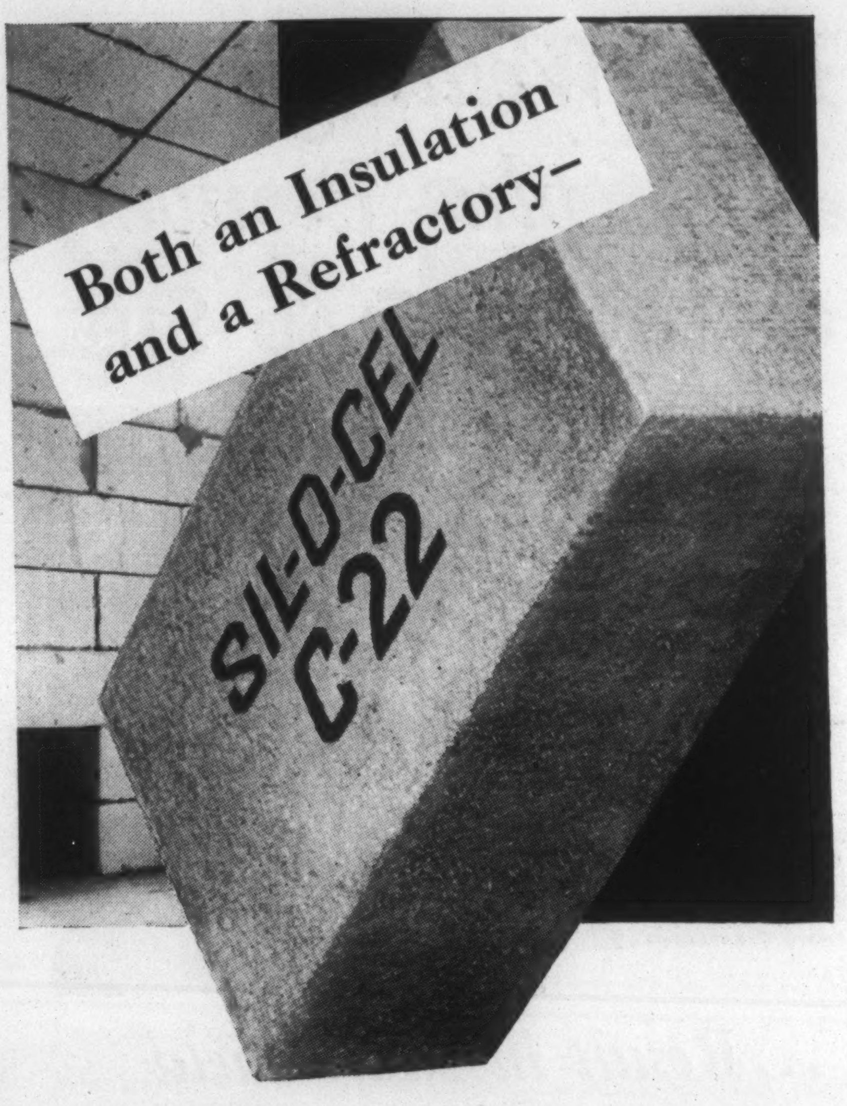

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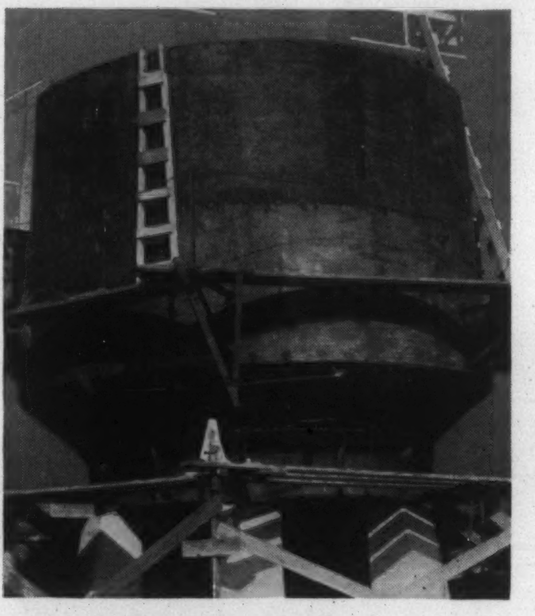

Photo of Nickel-Clad Steel caustic soda settling tank taken during construction. Conical bottom is 3-8", next 5 feet is 5-16" and top of shell yet to be added is 1-4" 10% Nickel-Clad. Tank is 18' dia. x 25' high. Nickel side welded with No. 35 Nickel vertical Metallic Arc Welding Wire. Built by Chicago Bridge & Iron Works, Birmingham, Ala., for a large alkali company.

•

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This groove was then welded with No. 35 Nickel Vertical Arc Welding Rod of ⅛" diameter, using reverse polarity. Welding from the top down required a heat of about 130/140 amperes.

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Oxy-Acetylene...Monel Gas Welding Wire. (For flux, see * below.)

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Carbon Arc...INCO Monel Carbon Arc Welding Wire No. 20.

for INCONEL

Oxy-Acetylene...Inconel Gas Welding Wire. (For flux, see ** below.)

Metallic Arc...Inconel Metallic Arc Welding Wire No. 32.

for NICKEL-CLAD STEEL
(for welding of Nickel side)

Oxy-Acetylene..."T" Nickel Gas Welding Wire.

Metallic Arc...INCO Nickel Metallic Arc Welding Wire No. 31 and No. 35†

Carbon Arc...INCO Nickel Carbon Arc Welding Wire No. 21.

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JOINING (7)

Welding & Cutting (7b)

C. A. McCUNE, SECTION EDITOR

Dimensional Changes and Internal Strains in Welds (Formänderungen und Eigenspannungen von Schweissverbindungen). E. SIEBEL & M. PFENDER. *Archiv für das Eisenhüttenwesen,* Vol. 7, Jan. 1934, pages 407-415. The dimensional changes and internal stresses were determined by measuring the changes in spacing during welding of a set of gage marks forming a network over the surface surrounding the weld. In electric arc welds of plates the internal stresses were so high as almost to equal the yield point of the plate. As these stresses extended parallel to the welds, however, they did not weaken them materially. In gas welds the internal stresses were smaller, especially when the work was unconfined and uniformly heated. The internal stresses were greatly reduced by annealing at 500°C. SE (7b)

Evolution of Fusion Welding and the Technical Literature (L'Evolution de la Soudure Autogene et la Presse Technique). C. FRANCHE. *La Technique Moderne,* Vol. 25, Oct. 1933, pages 658-660; Nov. 1933, pages 743-725. Abstracts of 45 articles on the subject from world literature. FR (7b)

Removing Surface Defects with Oxy-Acetylene Torch (Epaillage et Décriquage au Chalumeau Oxy-Acetylénique). M. TURBAN. *Arts-et-Métiers,* Vol. 87, Jan. 1934, pages 12-16. Study on the use of scarfing torch which leads to the following conclusions: (1) work with this torch is of low cost owing to high speed of process. (2) High strength steel chipping of which is difficult are worked with the scarfing torch as easily as mild steel. (3) In some cases it is possible to work on ingots not completely cooled. (4) Ingot stocking, between pouring and rolling station is avoided. (5) Some ingots which were previously discarded can be recovered by using present process. FR (7b)

Contribution to the Form of Nozzles of Oxy-acetylene Torches (Beitrag zur Düsenform von Schweissbrennern). JOH. TITSCHER. *Der Autogen Schweisser,* Vol. 6, Aug. 1933, pages 97-98. Comparative discussion of experiences with and advantages of Laval-nozzles which are used in place of cylindrical nozzles for oxy-acetylene-cutters. In cutting of material of more than 150 mm thickness the Laval-nozzles are superior and it is explained how they can be easily made from old, discarded nozzles. Kz (7b)

Design and Construction of an Arc Welded Truss Bridge at Kimberley, Tasmania. ROBERT CHARLES SHARP. *Journal Institution of Engineers of Australia,* Vol. 6, Jan. 1934, pages 3-9. *Appendix I.* A. BURN. page 9. *Appendix II.* G. D. BALSILE. pages 9-10. Paper sets out the history and topographical features of the site and discusses the reasons for adopting a certain type of construction. The methods adopted in the design of the truss and floor slab are outlined and the methods of construction together with a cost analysis are included. The first appendix deals with the question of liability to buckling of the top chord of an open type through truss. The second appendix advances tentative conclusions based on experience gained by the Public Works Department in the design and construction of welded bridges. WH (7b)

Welding for Pressure Vessels. ROBERT SULZER. *Institute of Marine Engineers,* Vol. 45, Dec. 1933, pages 257-300. Includes discussion; *Mechanical World & Engineering Record,* Vol. 94, Nov. 17, 1933, pages 1111-1113. Conditions which have to be fulfilled if welding is to be adopted for important work are discussed. Based on the results of numerous tests, the development of oxy-acetylene and arc welding in recent years is illustrated. In addition to the testing of pieces specially prepared for judging the skill of a welder, or for comparing electrodes, welding methods etc. the testing of finished work both by means of the Röntgen method and by taking testpieces is discussed. Annealing of welds and fatigue tests are touched upon. Taking small test pieces at irregular intervals of time is mentioned as a method of improving the quality of the work done. Mention is also made of a number of large experimental vessels tested to rupture. A survey is given of the progressive adoption of welding in the construction of pressure vessels. Examples are given of: boilers, steam distributors, vessels for storing dangerous liquids or gases under pressure. Welding is widely adopted in the construction of high pressure pipe lines. Kz (7b)

Testing of Suction Burners (Beitrag zur Frage der Prüfung von Saugbrennern). E. STREB & H. KEMPER. *Autogene Metallbearbeitung,* Vol. 27, Feb. 15, 1934, pages 54-58. A testing method for suction burners was developed which gives always reproducible results and a reliable basis of comparison. Ha (7b)

Rapid Progress of Welding. FEDERICO GIOLITTI. *Metal Progress,* Vol. 25, Mar. 1934, page 44. Comments on the wide use of welding in structures. WLC (7b)

Trends in Fusion Welding (Nouveautés et Tendances en Soudure Autogène). R. GRANJON. *Bulletin de la Société des Ingénieurs Soudeurs,* Vol. 4, Feb.-Mar.-Apr. 1933, pages 876-895. Lecture before French Welders' Society showing present position of fusion welding in France. Following points are discussed: (1) Selection of welding processes: oxy-acetylene and electric welding have their own field of application and are not generally competitors. (2) Weldability: There is a trend towards making heterogeneous welds, for instance, 12% Mn steel can now be welded by using 18/8, Cr/Ni steel as added metal. Added metal is no longer selected according to composition of metal to be welded but according to mechanical properties to be obtained (3) Trend towards welding with reducing conditions. (4) Trend towards standardization of added metal. (5) Trend towards standardization of tests for welds. (6) Use of atomic H: Process has only limited applications and, in France, three phase arc would be preferred. (7) Torch welding: There are about 60,000 torch welders in France against only about 4,000 arc welders. Experiments have been made to substitute other gases to C_2H_2 but never with great advantage. (8) CaC_2 and dissolved C_2H_2: Nothing new is noted in this connection. (9) Welding installation: Although oxy-acetylene welding is very largely used in France there is a lack of well studied complete installations as met in Germany. (10) C_2H_2 generators. For small capacity apparatus: trend is toward use of high pressure. (11) C_2H_2 purifying: Not enough attention would be given at this point. (12) Torches: Little progress has been made; torch with additional reducing flame is for instance not yet developed. Torches with air addition and torches with preheating flames for added metal are to be noted. (13) Nozzles have shown great improvement for gas cutting but not for welding. FR (7b)

Bottoms of Cylindrical Tanks (A Propos des Fonds de Réservoirs Cylindriques). H. GERBEAUX. *Revue de la Soudure Autogène,* Vol. 25, Sept 1933, pages 2858-2861. Usually bottoms are convex and designed with 2 radii one of great length which gives a sphere portion and one smaller at the periphery which gives a torus portion. Giving calculations at length author shows that in a typical case the stress, in connecting point between sphere and torus, is 16 times higher than in cylindrical portion of the boiler, furthermore there is a tension stress in sphere portion and a compression stress in torus portion whereas resulting shearing stress appears in connecting zone where most failures are noted in service. It is explained that working pressure, most often involves permanent distortion of this dangerous point fortunately giving it a much better shape without sharp variation of curvature, more liable to resist during service. Bottoms of elliptical shape are much more preferable. Bottoms with convexity towards outside must be preferred to those having their convexity towards inside because in first case dangerous point above mentioned is under compression whereas it is under tension in the second case, furthermore, in first case, butt weld can be used which allows continuity between body and bottom of boiler. FR (7b)

All-Welded Coach (Voiture en metal léger soudée). A. M. Hug. *L'Allègement dans les Transports,* Vol. 3, Jan./Feb. 1934, page 13. Refers to suburban car of the French Northern Railway. The body is entirely made of arc-welded light metal alloys. The resistance of the untreated alloys had to be taken into account in calculating the strength due to the loss in strength during welding. EF (7b)

Forward or Backward Welds? F. Hermann. *Sheet Metal Industries,* Vol. 7, Sept. 1933, pages 318-320. See "Right or Left Hand Welding," *Metals & Alloys,* Vol. 5, May 1934, page MA 202. AWM (7b)

Equipment Made with Oxy-Acetylene Welding (Travaux Effectués par Soudure Oxy-acétylénique). R. M. *Revue de la Soudure Autogène,* Vol. 25, Dec. 1933, page 2925. Making of a galvanizing trough and repair of a heavy crusher frame are explained and illustrated. FR (7b)

Works and Researches on Welding (Travaux et Recherches en Soudure). *Revue de la Soudure Autogène,* Vol. 25, Nov. 1933, page 2912. Short account on works in progress at the Office Central de la Soudure Autogène. (1) Formation of hard spots in cast Fe welds; an important study just begins on the subject. (2) Tables of data on oxy-acetylene welding, comprising gas consumption, welding rate, added metal weight, etc., are going to be made. FR (7b)

Study of Weldability of Steel (Etude de la Soudabilité des Aciers). *Revue de la Soudure Autogène,* Vol. 25, Dec. 1933, pages 2922-2924. This report deals only with oxy-acetylene welding. Points discussed are: (1) Carbon steel, (A) typical weldable steel is a very soft open-hearth steel composition and characteristics of which are given, (B) Changes of weldability with composition in carbon steels are explained, (C) Weldability of basic Bessemer steel is discussed and said to be poor. (D) Added metals for welding soft and very soft steels are classified into 2 groups namely soft carbon steel and alloy steel which are themselves classified into: Si-Mn steels, Cr-Cu steels and Ni steels. (2) Weldability of so called semi-stainless steels such as Cr-Mo-Cu steels, Ni-Cr-Cu steels is studied; in this case, base metal should be used as added metal. (3) Weldability of steels of high proportional limit of the marine type is discussed. These steels contain 0.15-0.20 C and alloy elements such as Ni, Cr, Mo, V. Weldability would be poor owing to alloy elements which favor quenching ability. (4) Weldability of pearlitic Mn steel is said to be good, added metal of same composition as base metal is used. (5) 14% Mn steel is only weldable with 18/8 Cr-Ni steel or 25% Ni steel as added metal. (6) Cr-Mo steels with 0.80-1.10 Cr and 0.15-0.25 Mn are weldable with very soft steel or Si-Mn steel as added metal. When Cr-Mo steel is used, welds must be heat treated. (7) 13% Cr Steel is welded with itself as added metal but welded pieces must be heat treated. (8) 18/8 Cr-Ni steels is also welded with itself as added metal, heat treatment is necessary to prevent weld decay, additions of Ti, V, Mo are also used in these steels to prevent intercrystalline corrosion. FR (7b)

Research in Welding (Travaux et Recherches en Soudure). *Revue de la Soudure Autogène,* Vol. 26, Jan. 1934, page 9. Short account on work in progress at the Office Central de l'Acétylène is given. (1) Weldability of steels: Tests are made on various steels furnished by French manufacturers. (2) Brazing of stainless steels: Brazing of 13% Cr steel has proved recently possible (by using a new type of brazing metal melting at 750° C. which allows to solidify at temperature under that of transformation so that there is no quenching effect in the metal during cooling. (3) Welding Al alloy: A new alloy "Alumag" is welded as easily as pure Al and properties of welded joint are similar to those of base alloy. FR (7b)

Manufacture of Compressed Air Vessels (La Construction des Réservoirs à Air Comprimé). *Revue de la Soudure Autogène,* Vol. 26, Jan. 1934, page 11. Manufacture is briefly explained. FR (7b)

Mixtures of Acetylene and Coal Gas (Les Mélanges d'Acétylène et de Gaz de Houille). *Revue de la Soudure Autogène,* Vol. 26, Jan. 1934, page 10. It is shown that those mixtures are not as good as pure C_2H_2 for welding purposes. FR (7b)

Profitable Cutting Operations. *Oxy-Acetylene Tips,* Vol. 13, May 1934, pages 107-108. Templets, machines and methods for simplifying and facilitating shaping by portable oxy-acetylene cutting machines are described and illustrated; considerable savings could be effected. Ha (7b)

How to Rebuild Valve Seats. *Oxy-Acetylene Tips,* Vol. 13, May 1934, pages 109-111. Worn and burnt automobile engine valve seats are economically built up by bronze surfacing; a wear-resisting, bronze welding rod of 1/8" diam. is recommended as it adheres easily to cast iron and has a very dense structure. Also cracks are repaired successfully by bronze-welding. Examples are described. Ha (7b)

Welded Repairs to Machinery. How to Deal with Cast Iron. *Gas Engineer,* Vol. 59, Mar. 1934, pages 149-151. Economy of welding is shown in reconditioning a fractured steam engine cylinder and a 6,000 volt generator casing. The special conditions prevailing in welding of cast Fe are discussed. The procedure is described in detail. A special chapter is devoted to bronze welding. WH (7b)

Novel Welded Frames Used in Monitor Roof Construction. *Engineering News-Record,* Vol. 112, May 3, 1934, page 557. Details of welded 21" I-beams making up frames for the roof construction of the Ford Motor Co., exhibit building at the Century of Progress. CBJ (7b)

Electrically Welded Tube Constructions (Elektrisch geschweisste Rohrkonstruktionen.) *Elektrizitätswirtschaft,* Vol. 33, Jan. 31, 1934, pages 35-36. The great possibilities which welded tubes offer as structural elements are emphasized and attention is focussed on a tower of 108 m. height recently completed at the Milano Exhibition. Seamless tubes and arc welding are utilized. The tube diameter tapers down from 432 mm. near the ground to 164 mm. at the top. An interesting intersection of 6 tubes is shown. WH (7b)

Modern Welding Equipment. *Electrical Review,* Vol. 114, Apr. 20, 1934, pages 555-556. Describes several processes of electric welding and apparatus developed therefore by the Westminster Engineering Co., Ltd. MS (7b)

The Office Central de l'Acetylene (l'Office Central de l'Acétylène). *Chaleur et Industrie,* Vol. 15, Feb. 1934, pages 115-118. Description of the laboratories for metallography, physical and mechanical testing. FR (7b)

The Welding Rod for Arc Welding. E. A. Hume. *Iron Age,* Vol. 132, Nov. 9, 1933, pages 20-21, 55. From a paper on the "Growth of the electric arc welding industry" read before the Pittsburgh meeting of the Association of Iron and Steel Electrical Engineers. Rapid increase in use of welding rods with carefully controlled coatings, for all classes of welding, is thus providing greater uniformity in both arc characteristics and improved quality of weld metal produced. VSP (7b)

Fusion Welding at the Agricultural Machine Show (La Soudure Autogène au Salon de la Machine Agricole). R. Salelles. *Revue de la Soudure Autogène,* Vol. 25, Feb. 1933, pages 2707-2709. Explains and illustrates some typical applications of fusion welding in agricultural apparatus construction. FR (7b)

Applications of Fusion Welding as seen at the 1933 Paris Show (Les Applications de la Soudure Autogene à la Foire de Paris). R. Salelles. *Revue de la Soudure Autogène,* Vol. 25, July 1933, pages 2821-2824. See *Metals & Alloys,* Vol. 5, May 1934, page MA 200. FR (7b)

HOW TO PRODUCE
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For Hardness of 48 to 52 Rockwell C use *"Wearweld"* electrodes. These shielded arc rods produce high density welds of exceptional toughness. A single bead on mild steel will have a hardness of 40 to 45 Rockwell C. Welds of multiple beads test 48 to 52 Rockwell C. On higher carbon steels the weld hardness is much greater. Grinding, to shape and size after welding, is reduced to a minimum due to the very flat smooth-surfaced beads produced by *"Wearweld."*

For Hardness of 30 to 45 Rockwell C use *"Hardweld"* electrodes. They produce hard, tough, shock and abrasion resistant surfaces. Hardness increases on cold working or quenching and the welds do not spall or check. The usual porosity present in high carbon deposits does not occur in welds made with *"Hardweld."*

For Wear Resistant Welds in Manganese Steel use *"Manganweld."* They work in a shielded arc to produce a flat bead with no surface checks. The weld metal has a high density; is extremely hard and tough. The hardness increases when the weld is cold worked. The wear resistance of welds made with *"Manganweld"* electrodes is equal to that of heat-treated cast manganese steel.

Ask for samples and complete procedures for easy welding with *"Wearweld"*, *"Hardweld"* and *"Manganweld"* electrodes.

THE LINCOLN ELECTRIC COMPANY
Welding Research Division **Cleveland, Ohio**

Arc Welding in Railway Shops. E. Dacre Lacy. *Railway Engineer*, Vol. 54, Dec. 1933, pages 375-376. In the construction and repair of locomotives arc welding is used on frames, motion parts, attachments, smoke-boxes, cabs, wheels, boiler pads, foundation ring corners instead of caulking, boiler flues, superheater tubes, flannery stay cups, domes. But the British Board of Trade at present does not allow the use of welded joints in steam boilers to carry the main load and welding on any reciprocating parts such as connecting and side rods. The economy of utilizing welding is shown on the reclaiming of worn crossheads and on the repair of broken spokes in wheel centers. Welding for repairing cracks in underframe sole-bars, headstocks, longitudinal and cross bars, gusset plates and knee pieces is discussed. Use of welding in the construction of new wagons is in its infancy in Great Britain. WH (7b)

Scientific Fundamentals of Fusion Welding (Les Bases Scientifiques de la Soudure Autogène). A. Portevin. *Bulletin de la Société des Ingénieurs Soudeurs*, Feb.-Mar.-Apr. 1933, pages 901-925. Lecture before French Welders' Society. Essential characteristics of welding process are: (1) Melting of edges to be welded and of added metal. (2) Localization of the phenomenon which involves marked thermal heterogeneity. First characteristic leads to consider welding process as (1) a foundry operation (2) and heat treatment operation, (3) a metallurgical operation involving chemical reactions. Scientific study of the process must comprise: (1) Enumeration of phenomena and variables. (2) Precise definition of aim of study and measurement of results. (3) Building up of laws between variables and results. Present case involves study of 4 variables i.e. (1) elementary chemical composition, (2) physico-chemical composition, (3) structure, (4) internal stresses. Each of these 4 variables is discussed at length. Then phenomena accompanying welding process are studied in detail in following chapters. (1) Localized phenomena during heating. Here, three zones are considered (a) heated zone without melting, (b) partially melted zone, (c) completely melted zone. In last section of this long section, effects of fluxes are discussed, these effects are classified in 3 classes (a) protection, (b) purification, (c) modification. (2) Localized phenomena during cooling are reviewed in the 3 zones above mentioned. (3) Global phenomena in the system welds-welded parts are dealt with. In last section of his lecture, the author studies chemical properties of welds and weldability of metal. It is concluded that weldability does not depend upon kind of metal to be welded only but is also a function of following factors: (a) Initial state of metal, (b) subsequent treatment of the weld (mechanical or thermal), (c) welding process (torch, arc, H). (d) Conditions of welding (kind of added metal, use of flux, gaseous atmosphere). (e) Conditions of service of welds, (f) Size and chief thicknesses welded. General conclusion is that thorough study of welding is a complex problem which involves knowledge of foundry metallurgy and heat treatment fields. FR (7b)

Evolution of Fusion Welding (Evolution de la Soudure Autogène). Albert Portevin. *Revue de la Soudure Autogène*, Vol. 26, Feb. 1934, pages 6-7. Owing to extension of process in bridge, aircraft, naval and pressure vessel construction, it is necessary to apply to a methodical development involving (1) Scientific study and rational experimentation. (2) Establishing practical rules for application of technical knowledge and establishing control processes. (3) Training of men from the simple welder up to the engineer. It is pointed out that the full study of the process involves: (1) Metallurgical knowledge for chemical reactions between molten metal and outside media. (2) Foundry knowledge for freezing and cooling phenomena. (3) Knowledge of heat treatments for structural modifications brought in solid metal through heat application. FR (7b)

Measurement of Weldability. Albert Portevin. *Metal Progress*, Vol. 24, Nov. 1933, pages 45-46. Coefficient of weldability is suggested in which the several properties of the weld metal will be weighted and combined to express the weldability of that metal for given conditions in which the properties combined in coefficient are of importance. WLC (7b)

Protection of Interior Walls of Acetylene Generators (Schutz der Innenwände von Azetylenentwicklern). K. Noack. *Autogene Metallbearbeitung*, Vol. 27, Apr. 1, 1934, pages 104-106. The Chemisch-Technische Reichsanstalt investigated a number of paints for use on the interior walls of acetylene apparatus to protect them from corrosion. The best result, complete protection against corrosion by hot lime water and C_2H_2 residues, was obtained by a paint composed of 16% (by wt.) Tornesit, 44% Xylol, 35% Lithopone, 5% Tricresyl-phosphate, in a layer of 0.25-0.35 mm. Ha (7b)

Physical Properties of Deposited Metal in the Arc Welding and Atomic Hydrogen Processes. L. Miller & C. R. Deglon. *Sheet Metal Industries*, Vol. 8, Feb. 1934, pages 131-133; Mar. 1934, pages 189-191; Apr. 1934, pages 252-253. A discussion of the fundamentals of the atomic hydrogen process. The effect of included oxides and nitrides on the physical properties of welds is shown. Age-hardening tests showed that short-arc welding with high-quality electrodes and the atomic hydrogen process yielded deposits which had no age-hardening tendencies. Concludes that nitrogen does not appear to have the detrimental results usually associated with it as far as practical results are concerned. The presence of oxygen is much more detrimental as low impact values result from it. AWM (7b)

Metallurgy of Gas-Welding (Zur Metallurgie der Gasschmelzschweissung)). Roland Mitsche. *Der Autogen Schweisser*, Vol. 7, Apr. 1934, pages 43-46. Discussion of metallurgical processes taking place in the weld and parent metal during welding. Dealing with grain size, the effect of additions to the filler material to refine the grain are discussed. Gas inclusions and recrystallization are dealt with. In conclusion improvement of the properties of welds by thermal and mechanical treatment is discussed. Kz (7b)

Welding of Aluminum Alloys (Uber das Schweissen von Aluminiumlegierungen). Ernst Mitterdorfer. *Der Autogen Schweisser*, Vol. 7, Apr. 1934, pages 56-58. Article refers to the research work of the laboratories of the "Aluminium-Industrie-Aktien-Gesellschaft", Neuhausen, published in "Technologie des Aluminiums und seiner Leichtlegierungen" by Professor Dr. Ing. O. Zeerleder. Choice of fluxes and filler materials are chiefly discussed and the technique employed in welding of "Anticorodal" and "Peraluman". Dealing with heat treatment of welded parts diagrams illustrate the changes in Brinell hardness on a line across the weld from parent metal to parent metal before and after the treatment of the weld. In conclusion data on tensile tests made with welded test pieces are dealt with. Kz (7b)

Application of Fusion Welding in the Construction and Repair of Boilers (Application de la Soudure Autogène à la Construction et la Réparation des Générateurs de Vapeur). C. Walckenaer. *Revue de la Soudure Autogène*, Vol. 26, Feb. 1934, pages 8-9. Construction of boiler having to resist pressure up to 70 kg./cm^2 as in those of the new power plant of Saint-Denis, near Paris, involves new problems due to mechanical and thermal stresses which can only be resolved through correct selection of material and processes. Welding can be resorted to when welds are not subjected to transverse stresses. Researches on fatigue failures of boilers under vibrations has lead to a better comprehension of materials having a high (endurance) fatigue strength. Tendency is to use added metals of special composition in order to have mechanical homogeneity at the expense of chemical homogeneity. In repair work great attention should be paid to weldability which is often not so well known as that of new materials used today in construction. FR (7b)

Welding of Bronze Castings (Schweissen von Bronzguss). Valentin Trunschitz. *Der Autogen Schweisser*, Vol. 7, Apr. 1934, pages 58-59. Deals with the choice of fluxes and welding rods and rules which have to be observed in welding bronze castings. Kz (7b)

A New Automatic Electric Special Welding Arrangement for Building of Automobiles (Eine neue selbsttätige elektrische Sonderschweisseinrichtung für den Automobilbau). H. Wilbert. *Automobiltechnische Zeitschrift*, Vol. 37, Apr. 10, 1934, pages 200-202. A special arrangement permits welding automatically curved seams by the electric arc, and is used mainly for welding chassis frames. Ha (7b)

Gas Cutting of Cast Iron (L'Oxy-Coupage de la Fonte). R. M. *Revue de la Soudure Autogène*, Vol. 25, Nov. 1933, page 2908. Gas cutting is used in cast Fe construction and repair. Gas cutting of cast Fe is quite different from that of steel; it is not the chemical action of O jet but the localized overheating of the flame which produces cutting. Width of cut is larger than in the case of steel; speed of cutting is also lower for cast Fe than for steel. Examples of application of the process are illustrated. FR (7b)

Welding in the World (La Soudure dans le Monde). *Revue de la Soudure Autogène*, Vol. 25, Nov. 1933, pages 2910-2911. Articles abstracted and explained are the following ones: Making opening in tubes with an automatic gas cutting machine (*Welding Engineer*, Sept. 1933). Absorption of gases by the metal during welding (*Welding Engineer*, no date given). Gas cutting of tubes (*Journal de la Soudure*, Sept. 1933). The Littoria Tower in Milan (Italia) (*Il Politechnico*, no date given). Device (stripper) for removing ingots from molds (*Génie Civil*, Sept. 2, 1933). FR (7b)

A Building with Welded Metal Structure (Un Immeuble à Ossature Métallique Soudée. R. Salelles. *Revue de la Soudure Autogène*, Vol. 25, Sept. 1933, pages 2864-2867. Description of building containing rooms for Swiss students at the University City in Paris is described. Details are given of welded parts which represent 50 tons in the 65 tons of the metal structure of the building comprising 50 student rooms. All welds were made by only 3 welders in 5 weeks with a consumption of 4,500 electrodes of added metal. FR (7b)

Ratio of Mixture and Shape of Flame of the Suction Burner under Varying Acetylene Pressure in the Burner Hose (Mischungsverhältnis und Flammenform bei schwankendem Azetylendruck im Brennerschlauch). E. Sauerbrei. *Autogene Metallbearbeitung*, Vol. 27, Feb. 27, Feb. 15, 1934, pages 59-62. Investigations of the relation of mixture to pressure lead to the conclusion that suction burners guarantee a satisfactory ratio of H_2C_2 to air, that is satisfactory welding work, only if the variations of H_2C_2 pressure in the hose remain within certain limits, and acetylene apparatus must be used only at a rate of H_2C_2 consumption that does not exceed this limit. This should be the leading point in the design of H_2C_2 producers. Ha (7b)

Gas Cutting (Autogenes Schneiden). R. Schneider. *Schweizerische Technische Zeitschrift*, Vol. 31, Feb. 22, 1934, pages 109-114. After general considerations paper discusses at length, devices and possibilities of application of gas cutting. Rapid spreading of gas cutting since its first application proves its value. GN (7b)

Fusion Welding of Alloy Steels and of Non-Ferrous Metals (Ueber Schmelzschweissung der legierten Stähle und der Nichteisenmetalle). Hugo Schroeder. *Werkstoffe und Korrosion*, Vol. 9, Jan. 25, 1934, pages 1-2; Feb. 25, 1934, pages 5-6; Mar. 25, 1934, page 9. Welding practice and physical constants important for the process are reviewed for alloy steels, Cu, Al, Ni, Ag, Pb, silumin, KS seawater alloy, monel metal and plated materials. The total required heat energy for welding equals $a \times d + c + (2b \times d)$; it is given in last column f of the following table where also the other factors can be found:

Material	a	b	c	d	e	f
	spec. heat cal./g.	heat conduct. cal./cm. sec. C°	heat of fusion cal./g.	melting point °C	total heat of fusion cal.	total heat of welding cal.
Iron	0.18	0.15	35	1400	259	623
V2A (V4A)	0.17	0.05	50	1400	288	428
Copper	0.16	1.0	42	1084	216	2254
Aluminum	0.2-0.4	0.5-0.22	85	659	342	552
Nickel	0.16	0.14	72	1450	305	711
Silver	0.06	0.99	21	960	78	1862
Lead	0.035	0.084	6	328	17	43
Monelmetal	0.125	0.06	68	1360	252	852
Silumin	as Al	0.39	about same as Al			
KS seawater		0.40				

Ha (7b)

Making, Appraising and Testing of Welded Seams (Ausführung von Schmelzschweissnähten und ihre Bewertung und Prüfung). Hugo Schroeder. *Chemische Apparatur*, Vol. 21, Apr. 10, 1934, pages 61-63. Processes of welding small parts especially in building of instruments are reviewed; methods to determine required thickness of a sheet and calculation af a "safety" number are explained and testing methods discussed. Ha (7b)

Resistance Welding of Non-ferrous Metals (Die Widerstandschweissung der Nichteisenmetalle). M. v. Schwarz & F. Goldman. *Zeitschrift für Metallkunde*, Vol. 25, Aug. 1933, pages 194-196. A discussion of the resistance welding of age-hardening aluminum alloys, with special reference to the avoidance of over-aging or over-heating with the maintenance of high strength properties. RFM (7b)

Design and Aesthetics of Assemblies Using Welding. Robert E. Kinkead. *Metal Progress*, Vol. 25, Feb. 1934, pages 34-37, 52. The stand is taken that mathematically correct design as to space and dimensions is aesthetically correct. Welding promotes this end removing the limitations of other methods of construction. WLC (7b)

Concentrated Stresses in Welded Structures. Robert E. Kinkead. *Metal Progress*, Vol. 25, Jan. 1934, pages 19-24. Three types of stress concentration commonly occur due to (1) change of contour, (2) residual stresses, and (3) defects in the weld metal. Concentrations due to contour are discussed especially with reference to those occuring with different types of bead on a lap joint. Residual stresses are insidious in that they may not cause immediate failure but a premature "fatigue" failure after the structure has been considered safe on account of its service record. Methods of minimizing the setup of such stresses and their relief are discussed. WLC (7b)

Means for the selection and control of the welding torch (Mittel zur Wahl und Kontrolle der Schweissbrenner). C. F. Keel. *Zeitschrift für Schweisstechnik*, Vol. 24, Jan. 1934, pages 17-19. Torch size is closely related to the thickness of the metals to be welded. The flow of acetylene through the torch may be determined by means of the equation $d^2.135 =$ liters/hour of acetylene (using d in mm.). A table shows amount of gas per hour required to weld sheets of from 3 to 15 mm. The author also describes two instruments for determining the torch bore. RRS (7b)

First Fusion Welded Industrial Building in England (Die erste autogen geschweisste Fabrik in England). C. F. Keel. *Zeitschrift für Schweisstechnik*, Vol. 23, Dec. 1933, pages 296-299. Describes a building at Harmondsworth, England, fabricated entirely by fusion welding. The frame of the building was welded into a single unit. Six illustrations give a view of the assembled framework, the method of joining roof members, and the welding of anchor and base plates. RRS (7b)

New Type Sky Carriers Use Welding. Robert Johnson. *Welding Engineer*, Vol. 18, July 1933, pages 22-23. Welding methods used in quantity production for transport airplanes are described. Ha (7b)

The Snowy River Flood of January 1934. N. G. Dempster & W. A. Ozanne. *The Commonwealth Engineer,* Vol. 21, Mar. 1, 1934, pages 227-234. Rainfall and floods converted 2 important Australian road bridges into a twisted mass of steel. A study of the behavior of the electrically welded members was made with the object to show where the failures in these structures occurred under conditions "which would never be reached in actual service." The investigation indicates that while the welding has successfully withstood very severe loads, it is undesirable to use it below a certain minimum size and that "stuck on" pieces are easily torn away. The twisted remains of heavy channel sections are in marked contrast to the welded lapped splices which for the most part remained undamaged. It was found that the exterior appearance of the weld was a most unreliable criterion of such factors as the effectiveness of penetration, the degree of porosity, and the physical characteristics of the deposited weld metal as judged from an examination of the broken weld. The welding of the bridges whose structural features and weld sizes are detailed, was not of poor quality. WH (7b)

The Development of Welding as Applied to Boiler Drums and Steam Receivers. C. H. Davy. *Steam Engineer,* Vol. 3, Feb. 1934, pages 198-201; Mar. 1934, pages 253-255; Apr. 1934, pages 291-294. Presented before the Inst. of Welding Engineers. An historical review and general discussion including radiographs of welds. AHE (7b)

Arc Welding of Aluminum and a Few Properties of the Weld Metal (Die Aluminium-Lichtbogenschweissung und einige Eigenschaften des Schweissmetalles). L. Anastasiadis. *Zeitschrift für Metallkunde,* Vol. 25, Nov. 1933, pages 285-286. Continuation of previous article, (ibid., page 141). Data are given on the corrosion (weight loss against time) in a 2% NaCl aqueous solution of Al sheet, weld-metal, and the weld in both hot-worked and cold-worked condition. Photomicrographs show crystal growth and columnar crystals in the neighborhood of the weld and show corrosive attack on the weld. It is concluded that electric arc welding of Al is practical. The cost is low and the mechanical and corrosion properties of the weld are quite satisfactory. RFM (7b)

Paper Models for Welding Shops (Papiermodelle für Schweissbetriebe). Baur. *Elektrizitätswirtschaft,* Vol. 33, Feb. 15, 1934, page 57. The expenses for making paper or cardboard models are negligible in comparison with the savings effected by short times for calculating the seam lengths, welding material consumption, welding times. Further advantages are discovery of faulty designs and instructive method of teaching apprentices. WH (7b)

Electric Welding at the Leipzig Spring Fair 1934 (Die Elektroschweissung auf der Leipziger Frühjahrsmesse 1934). K. Baumgärtel. *Die Elektroschweissung,* Vol. 5, Apr. 1934, pages 76-79. Describes novelties of German welding machines and auxiliary equipment as shown at Leipzig Spring Fair 1934. GN (7b)

Utilization of Electric Welding for Repairs (Die Anwendung der Elektroschweissung zu Reparaturzwecken). Bardtke. *Elektrizitätswirtschaft,* Vol. 32, Aug. 25, 1933, pages 350-353. Paper before the General Meeting of the Vereinigung der Elektrizitätswerke, June 1933, discusses and shows in 16 typical illustrations repairs performed on wheel rim, turnbuckle, piston rod, crosshead guide, crossing frog, locomotive cylinder, cast steel gear, cable impregnating kettle, worm gear and bath tube. EF (7b)

Progress Performed in Appliances and Methods of Electric Welding (Progrès Réalisés dans le Matériel et les Méthodes de Soudure Electrique). *La Technique Moderne,* Vol. 26, Jan. 15, 1934, pages 51-55. Resistance and arc welding are discussed. Last section of the article deals with manufacture of steam boilers and radiographic control of welds. FR (7b)

Fusion Welding in Motor Car Construction (La Soudure Autogène dans la Construction Automobile). *Soudure et Oxy-Coupage* (supplement of *Revue de la Soudure Autogène*) Dec. 1933, page 203. Application of various types of welding are briefly explained. FR (7b)

Metal Houses Constructed by Welding (Les Maisons Metalliques Construites par Soudure). *Soudure et Oxy-Coupage* (Supplement to the *Revue de la Soudure Autogène*) Vol. 10, Sept.-Oct. 1933, page 198. Description of 3 kinds of houses developed by 3 French firms. FR (7b)

Welded Machine Frames (Les Bâtis Soudés). *Soudure et Oxy-Coupage* (Supplement to the *Revue de la Soudure Autogène*), Vol. 10, Sept.-Oct. 1933, page 199. 4 different frames for grinding machine, roll support, bracket, calender, are illustrated. FR (7b)

Construction of Steel Sheet Radiators (La Construction des Radiateurs en Tôle d'Acier). *Soudure et Oxy-Coupage* (Supplement to the *Revue de la Soudure Autogène*), Vol. 10, Sept.-Oct. 1933, page 197. Note on a machine developed by Society A.G.A. permitting welding, by the oxy-acetylene method, of 15 domestic radiators simultaneously. This method would lead to radiators cheaper than those of Cast Fe whereas steel sheet radiators hand welded are more expensive than those of Cast Fe. FR (7b)

Present State of General Technique of Welding (Faisons le Point). *Revue de la Soudure Autogène,* Vol. 26, Feb. 1934, pages 41-73. Very long study comprising short articles by speacialists but only with letters (such as R.G., L.B.S., A.L., D.L., etc.) as signatures. Matters dealt with are. Part I. (1) Fusion welding. (2) Physics of fusion welding. (3) Chemistry of fusion welding. (4) Metallography of fusion welding. (5) Study of weldability. (6) Control of welds. (7) Study of general properties of welds. (8) Study of welded seam. (9) Study of molten metal. (10) Study of expansion and shrinkage. (11) Selection of welding processes. (12) Safe policy. Part. II. (1) Torch welding. (2) Calcium chloride. (3) Dissolved C_2H_2. (4) Oxygen. (5) C_2H_2 producers. (6) C_2H_2 purifying. (7) Expansion valves. (8) Oxy-acetylene installations. (9) Welding torches. (10) Added metals and products. (11) Oxy-acetylene welding methods. (12) Torch welding machines. (13) Oxy-acetylene welding with brass as added metal (soudo-brasure). (14) Gas cutting. (15) Forging, quenching and annealing with the help of torch. (16) Teaching of oxy-acetylene welding. (17) Apprenticeship in oxy-acetylene welding. Part III. (1) Carbon and metal arc welding. (2) Arc welding apparatus (postes). (3) Electrodes. (4) Arc welding methods. (5) Teaching of arc welding. (6) Apprenticeship in arc welding. (7) Atomic H welding. (8) Spot and shot welding. Part. IV. (1) Welding of mild steels. (2) Welding of miscelleaneous carbon steels. (3) Welding of new structural steels. (4) Welding of stainless steels (5) Welding of alloy steels. (6) Welding of Ni. (7) Welding of cast Fe. (8) Welding of Cu. (9) Welding of brass. (10) Welding of bronzes. (11) Welding of Al and its alloys. (12) Welding of Pb. (13) Welding of miscellaneous metals and alloys. (14) Coating of worn out part and superficial hardening of metal. FR (7b)

Tests on Added Metal Rods and Electric Welds (Les Essais d'Electrodes et d'Assemblages Soudés à l'Arc Electrique). *Revue de la Soudure Autogène,* Vol. 26, Jan. 1934, pages 2-4. Acceptance tests actually used by various French organizations are reviewed and compared. (1) A test bar of 9.78 mm. diameter (i.e. 75 mm.^{2} cross section) is cut in the added metal melted through common method for instance inside an angle shaped iron. On this bar, following properties are measured: tensile strength, proportional limit, elongation (in 70 mm.) and reduction of area. Density and Brinell hardness are also measured. (2) Mechanical tests on welds discussed in the article deal with following points: Methods of cutting test bars in welds for each type of test. Tensile, bending, impact and alternative flexion tests are described. Minimum figures to be obtained are given. A part of the article deals also with chemical analysis of welded and added metals. FR (7b)

Electric Resistance Welding for Steel Constructions (Elektrische Widerstandsschweissung bei Stahlkonstruktionen). Kurt Ruppin. *Elektrizitätswirtschaft,* Vol. 33, Feb. 15, 1934, pages 47-50. Reviews the various types of electric resistance welding machines which are on the German market and which are employed in structural work, vehicle and aircraft construction. WH (7b)

Modern Welding Technique (Die moderne Schweisstechnik). Kurt Ruppin. *Montanistische Rundschau,* Vol. 26, Feb. 16, 1934, (Section *Stahlbau-Technik*) pages 5-7. Germany has now 15,000 welding installations, of which 8,000 employ arc welding, 4,500 spot welding and seam welding, and 2,500 butt welding. The apparatus and procedure used in these processes are discussed, the latest developments in automatic welding and some of the most important practical applications are described. BHS+GN (7b)

Welding in Rolling Stock Repair Work. C. W. Brett. *Railway Engineer,* Vol. 54, Dec. 1933, pages 376-377. Discusses the application of welding to reconditioning of locomotive cylinders and railway axles, bearing housings, boiler plates, etc. The fabrication of boilers and boiler tanks by welding, is also considered. WH (7b)

Lowering Welding Costs by Careful Selection of Steel. Wilmer E. Stine. *Metals & Alloys,* Vol. 5, Apr. 1934, pages 74-76. The effect of quality of the metal welded upon the properties of the weld varies with the nature of the weld. In a plain butt weld which can be produced more rapidly more of the metal welded enters into the weld than in the V-butt weld where the weld metal is supplied from the rod. Factors affecting welding characteristics are oxidation, gaseous oxides cause gas holes and solid oxides result in slag inclusions or embrittlement by solution of oxides, non-metallic inclusions form larger slag inclusions by coalescence, changes of structure are most common in high carbon and alloy steels, solvent power of the metal for gas results in porosity in the weld metal, hot and cold shortness may result from high S and P. High Mn tends to porosity (1.5%) 0.25% Mn should be avoided for this same tendency, V addition tends to counteract porosity in Mn steels. Al will counteract some of the bad effects of Si in matter of gas absorption. Analysis recommended for general purposes C 0.20%, 0.15-0.25% Mn 0.45%, 0.35-0.60% Si 0.04%, 0.07% max.; S 0.05% max.; P 0.045% max.; Al none added, not over 2 oz. per ton added to steel; for considerable cold forming C as high as practical with range 0.07-0.15% and Mn 0.40% with other elements the same as for the general purpose variety are recommended. WLC (7b)

Rail-End Welding. W. M. B. Brady. *Welding Engineer,* Vol. 19, May 1934, pages 20-21. Type of electrode, preparation of rail ends, technique of welding, and temperature of atmosphere in their bearing on successful welds are discussed. In addition to usual stresses in welds rail ends are subjected to frequent impact stresses. An electrode with 0.25% C and 1.35% Mn gives satisfactory welds. Ha (7b)

Welded Goods Wagons in Germany. Otto Bondy. *Railway Engineer,* Vol. 55, Mar. 1934, pages 70-72. By means of careful design (structural features in 5 illustrations) and welded construction a 20-ton wagon with a tare weight of less than 9 tons has been evolved. The increase in permissible stresses in welded joints under the new German rules show:

kind of joint	kind of stress	factor k old	new	increase in %
butt welds	tension	.60	.75	25
	compression	.75	.85	13.3
	shear	.50	.65	30
	bending like tension and compression			
fillet welds	any	.50	.65	30

Rivets and screws are only used for parts which must be detachable or renewable. WH (7b)

Weldable Fittings and Ready Made Elements for Erecting Welded Pipe Lines (Raccords Soudables et Eléments Préparés pour la Construction de Tuyauteries Soudées). D. Cornil. *Bulletin de la Société des Ingénieurs Soudeurs,* Vol. 4, Nov.-Dec. 1933, pages 1096-1106. Lecture before the French Welders' Society. By suitable combination of all types of fittings described it is possible to solve any problem met with in pipe line installation. These ready made forged elements can be used with saturated low pressure steam, compressed air and gas, and water under a pressure up to 10 kg./cm.^{2} a second series of elements is used with steam pressure of 8 kg./cm.^{2} and water pressure of 15 kg./cm.^{2} a 3d series is used with steam pressure of 12 kg./cm.^{2} and water pressure of 30 kg./cm.^{2} at last a 4th series is available for steam pressure of 18 kg./cm.^{2} and water pressure of 50 kg./cm.^{2}. FR (7b)

Practical Welding of Copper Tubes. C. C. Downie. *Railway Engineer,* Vol. 55, Jan. 1934, page 15. Deoxidized Cu is better suited for welding than "tough-pitch" Cu. The Cu welding rod contains small amounts of P and Al. The preheating flame from an oil burner is a reducing flame. A slight sprinkle of flux is then applied to the surface to dissolve the oxide skin and dirt. A strip of asbestos board placed inside of the tube to be repaired or welded tends to prevent undue loss of heat. The oxy-acetylene welding should be conducted as quickly as possible, the tube should cool down slowly, and the line of weld well hammered. WH (7b)

What is A Weld. Gilbert Doan. *Metal Progress,* Vol. 25, Jan. 1934, pages 43-44. Definition of weld quoted states that it is joint maintained between 2 contact surfaces by atomic attractions across this joint. This definition is so stated that it may include joints in rubber, glass, wax, etc., where the joint is maintained by atomic attractions. A weld need not be made by heat, as cold welding of gold. WLC (7b)

Tests of Welds in Electrolytic Copper Made with Standard Commercial Welding Rods. W. J. Chaffee. *Welding Engineer,* Vol. 19, May 1934, pages 17-19. A P- bronze rod of a certain brand (grade D, Hobronz) produced welds of high strength and ductility; it has a large Sn content (amount not given) and is used with a long arc. Mechanical tests results are given in detail. Ha (7b)

Welding Technique in Bridge Construction (Schweisstechnische Konstruktionsaufgaben aus dem Brückenbau). Schmuckler. *Die Elektroschweissung,* Vol. 5, June 1934, pages 101-105. Author discusses welding technique to be applied (1) in constructing the welded junction point of a bridge, (2) in reinforcing a riveted bridge by welding. GN (7b)

Repair of Bronze Bells (A Propos des Réparations de Cloches en Bronze). R. Meslier. *Revue de la Soudure Autogène,* Vol. 26, Jan. 1934, pages 12-13. Five repairs through fusion welding or brazing are illustrated. In each case of bell repair it is first necessary to study in which sense expansion and shrinkage will act. When fusion welding is resorted to, added metal of the same composition as the bell i.e. containing 20-25% Sn should be used and the bell should be preheated at 600° C., after welding should be allowed to cool slowly. With brazing using special brass as added metal, operation is much more simple. It is not necessary to heat the bell at 600° C. only a slight localized heating can be resorted to. Repaired bells have the same resistance and tone as before. FR (7b)

Application of Fusion Welding in a Large Boiler Shop (Les Applications de la Soudure Autogène dans un Grand Atelier de Chaudronnerie). R. Meslier. *Revue de la Soudure Autogène,* Vol. 25, Nov. 1933, pages 2904-2907. Description of Arras shop of the Société de Chaudronnerie et Constructions Mécaniques de Paris et du Nord. Before each job is started, a preliminary study of the job is made. Examples of jobs done are illustrated and explained. FR (7b)

Stainless Steels (Les Aciers Inoxydables). L. Moreau. *Bulletin de la Société des Ingénieurs Soudeurs,* Vol. 4, Nov.-Dec. 1933, pages 1084-1095. Lecture before French Welders' Society. First part of the lecture studies, in general terms, stainless steels, their composition, their manufacture, their fabrication: rolling, forging, molding, stamping, machining. Ni-Cr steels being chiefly dealt with. A section of the lecture is devoted to joining of stainless steel. For oxy-acetylene welding of those steels, a torch of no more than 75 liters C_2H_2 per hour and per mm. to be welded should be used. When thickness of sheets to be welded exceeds 3 mm., their edges should be beveled. Flame should be kept reducing and a good flux of boric acid, borax or Na silicate should be used to dissolve Cr oxide film formed. Added metal used is of the same composition as the metal to be joined. For welding stainless steels a new type of torch has been recently developed in which an additional preheating flame, C_2H_2-air, surrounding welding flame is applied. Intercrystalline precipitation peculiar to these steels is dealt with and well known ways to obviate this defect are reviewed. For soft silver soldering of these steels, in decoration works, a silver base added metal melting at 750° C. has been developed. In last section of the lecture pickling of stainless steels and hardening of austenitic steels by cold working are explained. FR (7b)

Welding of Tubes on Boiler Steel Plates (La Soudure des Tubes sur les Plaques Tubulaires en Acier). M. Oudet. *Bulletin de la Société des Ingénieurs Soudeurs,* Vol. 4, Mar.-Apr. 1933, pages 861-866. Cu is largely used in France in fire boxes whereas similar parts are made of steel in U. S. A. It is concluded that U. S. practice is preferable. For boiler plates steel must, without any doubt be preferred to Cu. Disadvantages of Cu plates are reviewed. Chief disadvantage of steel plates was met in difficulty of having tightness in joints between plates and tubes but this now easily overcome with welding. Contrary to what would be thought at first sight, no difficulty is met to get a tight joint between steel plate and Cu side walls. In last section details are given for joining tubes to plates and practice advocated can be summarized as follows: a Cu sleeve must be placed in the plate hole, tube is set in position, and subjected to action of a mandrel, then its edges are beaten down in order to provide desired tightness under pressure, only when this is made edges of tubes can be welded to plate, the boiler being full of water. FR (7b)

Wear-Resistant Elkonite and Elkaloy Electrodes for Electric Resistance Welding and Heating (Verschleissfeste Elkonite-und Elkaloy-Elektroden für elektrische Widerstanch-Schweissung und-Erwärmung). K. Ruppin. *Elektrowärme,* Vol. 4, June 1934, pages 138-140. Elkonite is an alloy with a W-base which possesses very high hardness and resistance to wear, Elkaloy a Cu base which is hardened by a patented process so that it can be used as the former. When used as electrodes they are water-cooled and with high energy and very short current impulses give very good welds. Rustless steels, Al, brass, Zn, Cu, Fe galvanized sheet, Pb, Ni, Ag and Au can be welded with these materials, also different materials, as Cu with brass, brass with Fe, Pb with Zn, can be welded satisfactorily. Applications are described in airplane, automobile, and other industries. Ha (7b)

Electric Welding in Boiler Construction (Elektrische Schweissung im Dampfkesselbau). Willi Prox. *Archiv für Wärmewirtschaft,* Vol. 15, Mar. 1934, pages 67-70. Author discusses at length application of electric welding in boiler construction. The mechanical requirements that electric welds have to meet and the specifications of building and testing are considered. GN (7b)

Welded Bearing Bosses. V. A. Prince. *Welding Engineer,* Vol. 17, Nov. 1932, page 22. See *Metals & Alloys,* Vol. 5, May 1934, page MA 198. Ha (7b)

Actual Position of Radiometallography. Application to fusion welding (Etat Actuel de la Radiometallographie. Applications à la Soudure Autogène). H. Pilon. *Bulletin de la Société des Ingénieurs Soudeurs,* Nov.-Dec. 1933, pages 1107-1125. Lecture before the French Welders' Society. The Author describes apparatus, continuously improved, used in inspection of metal and especially of fusion welded seams. Some examples of application of equipment described. FR (7b)

Some Applications of Welding Processes in a Large Railway Shop (Quelques Applications des Procédés de Soudure dans un Grand Atelier d'une Compagnie de Chemin de Fer). A. Penit. *Bulletin de la Société des Ingénieurs Soudeurs,* Vol. 4, Aug.-Oct. 1933, pages 1014-1030. Lecture before French Welders' Society. Welding is resorted to in the following cases: (1) Wheel cracks in wheel are repaired with electric welding. (2) Frame reinforcement plates are welded to frame members. (3) Fire box supports are welded to the frame. (4) Welding is largely used for repairing broken cylinders, example is explained and illustrated in which a cylinder bottom has been replaced by a steel one electric welded to the cast Fe body. Such repairs have given good results even in high pressure cylinders. (5) Oxy-acetylene welding is largely applied for replacement of parts in Cu or Fe fire boxes. (6) All tubing portions are assembled by welding. (7) Numerous other applications, of welding in construction, repair and tool equipments as well as of gas cutting are given. FR (7b)

Effect of Heat of Welding on Tensile Properties of Joint and Material (Einfluss der Erwärmung beim Schweissen auf die Festigkeitseigenschaften von Verbindung und Ausgangswerkstoff). H. Kleiner & K. Bossert. *Autogene Metallbearbeitung,* Vol. 27, May 1, 1934, pages 131-139. Macroscopic and microscopic examinations, hardness, tensile, impact and endurance tests were made with welded structures in order to find the reason that fracture of a welded joint occurs usually in a short distance of the seam and parallel to it. Tensile tests did not give any positive results; the tensile strength was only slightly inferior nearest to the seam. Endurance tests, however, showed a reduction of endurance strength of about 10% due to the heat-treatment caused by welding, very likely on account of intercrystalline changes. The notch-impact test showed the most positive results. Progressive and retrogressive welding produced in the material a dangerous zone at about 50 and 75 mm. resp. distance from center of seam with a reduction of about 20% notch-toughness which assumed its normal value again at a distance of 90 and 130 mm. resp. Fractures occur mostly in this dangerous zone. The reason for the occurrence of this notch-brittleness is seen in the critical annealing after critical deformation, that is at 500°-600° C. It could not be satisfactorily established whether a change of intercrystalline structure alone or in conjunction with the annealing causes the reduced notch-impact strength. Hardness test confirmed previous experience that the weld possesses greater hardness than the material. Near the weld the hardness was somewhat lower but assumed normal values in short distance from the weld. The different heating in the welding process reduced yield point, endurance strength, notch-toughness and hardness in the zones next to the weld, this influence being noticeable up to 130 mm. distance. Progressive welding was in every respect better than retrogressive welding. Ha (7b)

New Things and Trends in Fusion Welding (Nouveautés et Tendences en Soudure Autogène). R. Granjon. *Revue de la Soudure Autogène,* Vol. 25. Apr. 1934, pages 2750-2758. See "Tendencies and Novelties in Fusion Welding", *Metals & Alloys,* Vol. 5, June 1934, page MA 268. FR (7b)

Fusion Welding in the Decorative Arts (Schmelzschweissung im Kunsthandwerk). Rudolph Geyer. *Autogene Metallbearbeitung,* Vol. 27, June 1, 1934, pages 188-189. The author describes his technique to use welding torch and material, especially wires, for obtaining artistic effects, in sculptures and busts. Ha (7b)

Current Shop Welding Practices. J. C. Holmberg. *Iron Age,* Vol. 133, Feb. 15, 1934, pages 31-34. From a paper read before the Montreal chapter of the American Society for Steel Treating in Dec. After reviewing standard practices for welding and treating mild steel vessels, author outlines welding technique for stainless Fe and steel. Concludes with a number of practical questions and answers. VSP (7b)

Heavy Weldings for Boulder Dam. Charles H. Jennings. *Metal Progress,* Vol. 25, Mar. 1934, pages 30-34. Describes the design of penstock gates used in Boulder Dam and the methods of training welders to produce welds in accordance with A. S. M. E. specifications. WLC (7b)

Properties of Welds in High Strength Structural Steel with Different Electrodes (Eigenschaften von Schweissverbindungen aus Hochbaustählen mit verschiedenen Elektroden). W. Lohmann & C. H. Schulz. *Archiv für das Eisenhüttenwesen,* Vol. 7, Feb. 1934, pages 465-471. Structural steels containing Si, Mn, Cu, and Cr, were welded with plain carbon and alloyed steel and bare and coated electrodes. In the fused-in metal the C, Si, Mn, and Cr were decidedly lowered, but not the Cu. There was more or less N_2 pickup, this being less with coated electrodes. The notched bar impact resistance was largely dependent on the N_2 content. Welds with coated electrodes gave better fatigue test values, due probably to the greater porosity of the welds with bare electrodes. SE (7b)

Welding of Structural Steels with Particular Consideration of Different Electrodes (Beitrag zum Schweissen von Hochbaustählen unter besonderer Berücksichtigung verschiedener Elektroden). F. W. Lohmann. *Mitteilungen aus dem Forschungsinstitut der Vereinigte Stahlwerke Aktiengesellschaft Dortmund,* Vol. 3, No. 10, Dec. 1933, pages 267-294. Structural steels St37, St48 and St 52 were welded with different kinds of electrodes. It was found that the composition of the electrode material takes places in the welding deposit, generally C, Mn, Si and Cr contents decrease to a large extent; Cu is changed only slightly. Selection of proper covering of the electrode permits a regulation of the change. Composition of the weld is influenced also by the composition of the parent material. Usually, the content of N is increased which depends on the kind of electrode cover while the composition of the electrode itself had no effect. Notch-toughness is influenced by N content, with low N the notch-toughness of the parent material can be obtained in the weld. Aging reduces notch-toughness of a weld, the higher the N content. The composition of the parent metal affects both composition and properties of the weld, the tensile properties increase with the tensile strength of the parent material. The effect of annealing above the transformation point depends mainly on the N content: tensile strength, yield point and notch-toughness decrease with the higher N. With low N the 2 former decrease only little but notch-toughness shows a decided increase. The toughness of the weld had only little effect on the endurance-impact test. Welds made with covered electrodes behaved better under bending-oscillating test than those made with bare electrodes, very likely due to greater porosity and slag inclusions in the latter. Bending-oscillating strength can be increased by removal of the weld bulge and by annealing if N is low. Ha (7b)

Oxy Acetylene Welding of Stainless Steels (La Soudure Oxy-acetylénique des Aciers Inoxydables). R. Meslier. *Revue de la Soudure Autogène,* Vol. 25, Mar. 1933, pags 2728-2729. Method explained can be summarized as follows: Capacity of torch should not exceed 75 liters C_2H_2 per hour and per mm. of thickness to be welded. Torch flame must always be perfectly neutral. Added metal must be of same composition as that of sheet metal, if suitable adding metal rods are not available, they should be sheared from the sheets. Use of a flux is absolutely necessary. It must be applied on the back of the seam and preferably stuck with Na silicate. Same process can be used for pasting flux on adding-metal bars but bare rod can also be resorted to if a torch with air—C_2H_2 flame is used in order to speed operation. As soon as thickness reaches 4 mm., edges of sheets must be beveled. FR (7b)

Some Interesting Applications of Oxy-Acetylene Welding (Quelques Applications Intéressantes de la Soudure Oxy-Acétylénique). R. Meslier. *Revue de la Soudure Autogène,* Vol. 25, Feb. 1933, pages 2710-2711. Article is devoted to repair jobs. Repair of big cast Fe tank, of a propeller shaft supporting arm, of a frame, of large marine pump cover is explained and illustrated. Last section of the article explains manufacture, by welding, of a 700 liter dredge bucket in which bottom is of cast steel, belt of mild steel and working edge of semi-hard steel. FR (7b)

Fusion Welding with Lead (La Soudure Autogène au Plomb). A. J. T. Eyles. *La Revue Industrielle,* Vol. 63, Sept. 1933, page 464. Abstract from *Electrical Review,* May 5, 1934; see "Lead Welding," *Metals & Alloys,* Vol. 5, May, 1934, page MA 200. FR (7b)

Metallurgical Aspects of a New Oxyacetylene Method of Welding in the Oil Industry. F. C. Hutchinson. *Oil & Gas Journal,* Vol. 31, Oct. 20, 1932, pages 74-75. Before Mid Continent Section American Society of Mechanical Engineers. Discussion of the new welding process based on the use of carbonizing flame or of a flame suitably manipulated to produce a carbonizing effect. VVK (7b)

Welded Instead of Cast (Geschweisst statt gegossen). L. Hunsicker. *Autogene Metallbearbeitung,* Vol. 27, Mar. 1, 1934, pages 68-70. Example of a welded disc with ribs of 2000 mm. diam. for a heat-exchanging device which could be made more satisfactory in this manner than by casting as no unknown internal stresses by the fluctuating temperatures which are sure to occur in a casting, had to be considered. Ha (7b)

Pressure Vessels of Welded Construction. J. C. Hodge. *Engineering Journal,* Vol. 15, Sept. 1932, pages 417-422. The extent to which welded joints may be safely used in pressure vessels, such as boiler drums, has been a matter for discussion for years, and this method of construction is now permitted under proper restriction as to the welding methods employed. The paper describes the properties of satisfactory welded seams of pressure vessels, as regards tensile strength, resistance to impact and fatigue, chemical composition, etc., and describes the testing procedure for such joints and the precautions which must be taken in relieving the stresses set up by the welding process. VVK (7b)

Repair of Damaged Gray-Iron Pieces by Gas-Fusion Welding (Wiederherstellung beschädigter Graugusskörper durch Gasschmelzwarmschweissung). W. Knoch. *Autogene Metallbearbeitung,* Vol. 27, Mar. 1, 1934, pages 74-76. Experience with repairs of gray iron castings by gas fusion welding has found it to be equivalent to electric welding; the piece is heated to dark-red before the actual welding operation. The advantage of gas-welding over electric welding is seen in that it is not necessary to fill the piece with sand (to prevent flowing away of the liquid electrodes). Examples of large cylinders are illustrated. The practice as employed in the German State Railways showed a considerable savings in favor of gas welding. Ha (7b)

An Engineering Appraisal of the Welding Processes. Robert E. Kinkead. *Metal Progress,* Vol. 23, Dec. 1933, pages 15-18. Two types of energy may be used in welding, heat and pressure. Welds may be classified as to the amount of heat they use, (1) a melting temperature such as thermit, arc, and gas torch welding where the joint is actually a casting, (2) where a melting temperature is not attained and pressure is applied as in resistance welding or modifications of the old "forge" weld. The properties of the weld or its similarity in properties to the base material depends upon the use of filler material of the same composition and the protection of the metal during cooling from changes in composition due to the effects of the heat. The heat may also affect the properties of the base metal by changes in its structure. These adverse effects of the heat of welding may be partially taken care of by subsequent heat treatment of the weld or the entire welded structure, or by cold or hot work of the weld and adjacent metal. The suitability of welding for a given production or repair job depends upon the importance of the integrity of the weld metal, the ability to approximate the composition of the metal joined, the amount of damage done to the microstructure of the base metal and the possibility of correcting such damage to a satisfactory degree. WLC (7b)

The Human Factor in Arc Welding. W. P. Digby. *Engineer,* Vol. 157, June 29, 1934, pages 652-653. Gives results of a series of tests carried out over a period of years showing tensile test results on material welded in various ways and by different workmen to show variations in the human machine. LFM (7b)

Relationship of the Welding Art to the Steel Casting. R. A. Bull. *Steel,* Vol. 94, Apr. 30, 1934, pages 30-32. Welding is applied to steel castings for repair work and for fabrication by joining them to wrought steel parts. When severe stresses are to be encountered, properties of the weld-metal should be similar to those of the parent metal. Many alloy cast-steels are available, but fusion welding on alloy steels is restricted largely to such parts as can be heat treated after welding. There is more sound metal, proportionately, in cast-steel than in weld-metal. In the desire to lighten structures and machines, rigidity of the parts should not be disregarded. Steel casting provides the maximum degree of stiffness. Coöperation between metallurgists and welders to develop a greater variety in the properties of deposited metal will extend the uses of welding. MS (7b)

Recent Development of Oxy-acetylene and Arc Welding (Les Progrès Récents de la Soudure Oxy-Acetylénique et à l'Arc Electrique). R. Granjon. *Revue de la Soudure Autogène,* Vol. 26, May 1934, pages 2-4. Lecture at the "Conservatoire des Arts-et-Métiers". Most important progress made recently are: improvement of weldability of steels which has been achieved by lowering C content and obtaining suitable strength by alloy addition. Use of flux coated electrodes and torches with additional C_2H_2-air flame which protects the metal against oxidation is said to be a valuable improvement. FR (7b)

Procedure Control in Welding. Robert E. Kinkead. *Metal Progress,* Vol. 25, June 1934, pages 30-33. Formulation of strict procedure control in welding is essential to good results. This control should extend over all details from design to final acceptance testing, leaving no element of judgment except in strictly routine matters to the workmen. Effective methods of acceptance tests of non-destructive nature do not eliminate necessity for procedure control but make its need more apparent in quantity of work rejected when such control is not employed. Precise instructions covering materials and methods for all operations will keep under control the factors of chemical analysis of steel welded, welding rod, size and shape of weld, heat amount and travel and methods of stress relieving. WLC (7b)

Welding and Cutting Technique at the Leipzig Spring Fair 1934. H. Kemper. *Autogene Metallbearbeitung,* Vol. 27, Apr. 1, 1934, pages 97-101. Describes and illustrates equipment, instruments and processes. Ha (7b)

Stress Distribution in Sheet Beams with Interrupted Welds Seams (Die Spannungsverteilung in Blechträgern mit unterbrochenen Schweissnähten). Rudolf Kalina. *Der Stahlbau,* Vol. 7, Mar. 2, 1934, pages 37-40. The welded sheet beam is an especially suitable structural element in steel construction. In such beams the joint of the girder plates with the tie plate can be made either by means of continuous channel seams or, in analogy with the riveted sheet beam, by interrupted seams. Accurate calculation of the stresses in a sheet beam with interrupted weld seams shows relatively large deviations from stresses calculated by common calculation methods, that, therefore, give no true picture of the actual stress conditions of the welded sheet beam. GN (7b)

Fusion Welding of High Pressure Vessels combined with X-ray Examination. R. Rankin Lynn. *Journal West of Scotland Iron & Steel Institute,* Vol. 41, Nov. 1933, pages 19-25. X-ray examination of the welding of pressure vessels is generally discussed. GTM (7b)

Arc Welding by Alternating Current and Direct Current Are Compared. J. F. Lincoln. *Steel,* Vol. 94, Apr. 2, 1934, page 36. Under all conditions of welding better results can be obtained with a proper d. c. than can be obtained with any a. c. arc. Although a. c. often gives a less porous weld than d. c., arc characteristic is inferior, and power cost is higher. There is also the difficulty of obtaining as good an electrode as is available for use with d. c. MS (7b)

Three Repairs of Ships by Fusion Welding (Trois Reparations de Navires par Soudure Autogéne). Maurice Lebrun. *Bulletin de la Société dés Ingénieurs Soudeurs,* Vol. 4, Aug.-Oct. 1933, pages 1031-1038. Lecture before French Welders' Society. Repairs explained and illustrated are the following ones: (1) Reinforcement of the frame of stern post of the petroleum boat "Omphale". Opening for screw in the stern post was reduced by welding 2 cross pieces of 214 x 214 mm. section and 2 side plates. This repair aimed at reducing excessive vibration of the stern post. Arc welding was preferred although oxy-acetylene welding could have been resorted to. (2) Repair of low pressure cylinder of petroleum boat "Pallas." A fissure of 45 cm. length was filled by arc welding after special preparation of edges of the broken portion. (3) Repair of the boiler of the petroleum boat "Briseis." In this case tubes were welded to boiler plates without using Cu sleeves which are strongly advocated by boiler maker specialists. FR (7b)

Liquid Welding Agent for All Metals (Flüssiges Schweissmittel für alle Metalle). Paul Wiessner. *Maschinenschaden,* Vol. 10, 1933, pages 181-182. Utilization possibilities of and practical experience with a novel liquid alkaline welding flux suited for all metals including Al and for welding of different metals. Analysis not given. EF (7b)

FINISHING (8)

H. S. RAWDON, SECTION EDITOR

How Attractive Finish Helps Metal Products Sales. 8—Selecting the Pickling Equipment. Herbert R. Simonds. *Iron Age,* Vol. 133, Jan. 25, 1934, pages 20-23. Describes some of the modern pickling equipment such as wire baskets, tanks, fastening, crates and automatic machinery. Some Ni alloys such as Monel metal are particularly resistant to pickling acids. Principal disadvantage of monel metal equipment is heat dissipation when high temperatures are used. VSP (8)

How Attractive Finish Helps Metal Products Sales. 11—Selecting the Proper Coating. Gustaf Soderberg. *Iron Age,* Vol. 133, Feb. 15, 1934, pages 22-24. Gives practical suggestions governing the selection of electrodeposited coatings. Includes 2 tables—one showing characteristics of different coatings, and the other giving processing data. VSP (8)

How Attractive Finish Helps Metal Products Sales. 12—Abrasive Cleaning. Herbert R. Simonds. *Iron Age,* Vol. 133, Mar. 1, 1934, pages 20-24. Describes features of abrasive cleaning of metal especially as applied to preparing surfaces for enameling. VSP (8)

Attractive Finish Helps Metal Products Sales. 15—Polishing and Buffing. Herbert R. Simonds. *Iron Age,* Vol. 133, Mar. 29, 1934, p. 24-27, 74; April 12, 1934, pages 16-19, 74. Describes features covering the care and selection of polishing wheels and abrasives, and outlines present trend toward use of automatic polishing machinery. Discusses some important features in building up a head on polishing wheels and many points in modern buffing practice. VSP (8)

How Attractive Finish Helps Metal Products Sales. 16—Polishing Different Metals. Herbert R. Simonds. *Iron Age,* Vol. 133, Apr. 26, 1934, pages 18-21, 70. Deals with problems arising in polishing some of the more important industrial metals—stainless steel, brass, Al, Ni, Zn and monel metal. VSP (8)

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Diffusion Phenomena as an Aid in Metal Coating Technique (Diffusionsvorgänge als Hilfsmittel der Metalloberflächentechnik). Kurt Nischk. *Oberflächentechnik,* Vol. 11, Apr. 3, 1934, pages 79-80. The principles of improving a metallic surface by diffusing another metal or non-metal into it are explained. A certain degree of chemical affinity of the materials is required so that solid solutions or compounds can be formed. The common methods are mechanical plating; electroplating; spraying, rubbing or brushing on; application of an oxide of the diffusing material followed by heating in reducing atmosphere; and bringing the added material as vapor in contact with the surface. Examples of each are given and patent literature cited. Ha (8)

Metal Finishes used in Modern Architecture. S. Wernick. *Metallurgia,* Vol. 9, Apr. 1934, pages 191-192. Abstracted from lecture; brief exposition of various metal coating methods used commercially. JLG (8)

How Attractive Finish Helps Metal Products Sales. 4—How to Minimize Cleaning Expense. Robert W. Mitchell & Herbert R. Simonds. *Iron Age,* Vol. 132, Dec. 7, 1933, pages 18-21. Substantial savings are made by manufacturers by adopting modern methods and equipment for metal cleaning. Cleaning compounds may be tested by shaking 10 c.c. of the oil or grease to be removed with 90 c.c. of cleaning solution and noting ease, completeness and stability of emulsion. Includes test for discoloration. Largest item in cleaning cost is labor and overhead. Some of the cleaning compound of the future are the alkylated naphthalene sulphonic acids, the sulphonated fatty alcohols, the orthosilicates, etc. VSP (8)

How Attractive Finish Helps Metal Products Sales. 5—Cleaning as a Production Process. R. W. Mitchell & Herbert R. Simonds. *Iron Age,* Vol. 132, Dec. 21, 1933, pages 22-26. Describes some of the manufacturing economies which may be secured by proper cleaning processes. VSP (8)

Non-Metallic Coatings (8f)

Vitreous Enamels and Colours as used for Cast Iron and Steel. A. England. *Foundry Trade Journal,* Vol. 50, Jan. 4, 1934, pages 3-4. England briefly reviews the history of vitreous enameling and then discusses modern methods of enameling—dry and wet processes. Importance of expansion and elasticity is emphasized. Paper closes with description of steel-shot enameling and cast iron wet and dust processes. OWE (8f)

Symposium on Cement Lined Water Mains. *Journal American Water Works Association,* Vol. 25, Dec. 1933, pages 1728-1780. Introductory statement by Leonard P. Wood. Information from some 20 contributors on cement-lined pipe, problems encountered, methods of treatment and the development of a new low-soluble cement lining. VVK (8f)

Practical Experience with Modern Paints for Metals with Oil, Nitrocellulose and Artificial Resin Base. (Erfahrungen aus der Praxis mit neuzeitlichen Anstrichstoffen für Metalle auf der Basis von Oelen, Nitrozellulosen und Kunstharzen). E. Krumbhaar. *Farbe & Lack,* May 31, 1933, pages 257-259. See *Metals & Alloys,* Vol. 5, May 1934, page MA 207. EF (8f)

Paints for Gasworks Plant and Buildings. Notes on the Formulation of Oil Paints. J. T. Lawrence. *Gas Engineer,* Vol. 59, Feb. 1934, pages 85-87. A critical discussion on binders, pigment, red lead and other rust-inhibiting paints for priming metallic surfaces. The advantages and shortcomings of red lead, carbon black, graphite, basic Pb chromate are considered. The utilization of the latter in combination with Ba-sulphate and Mg-silicate is recommended as rust-inhibiting pigment. WH (8f)

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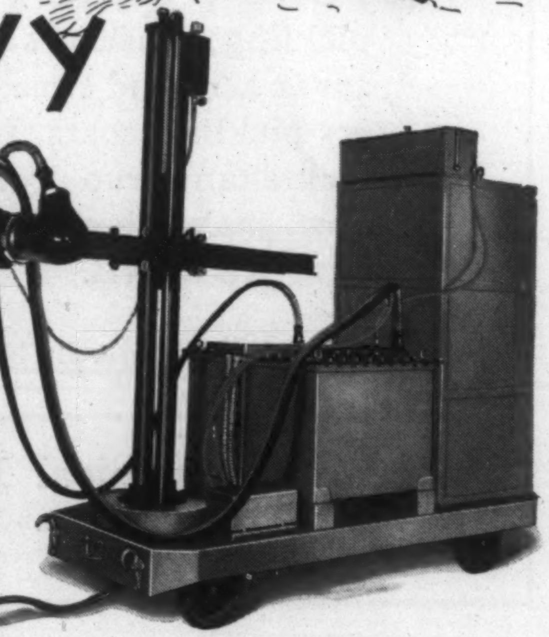

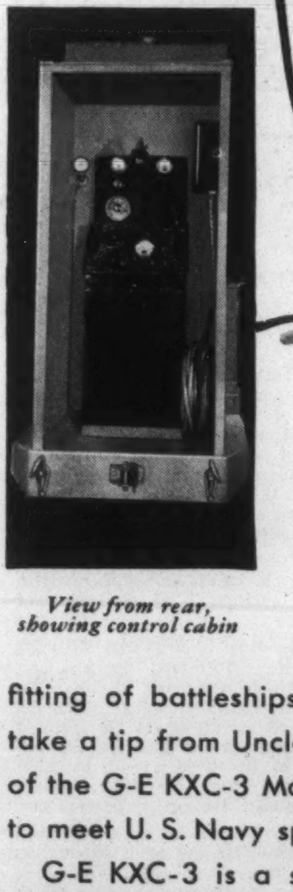

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TESTING (9)

Inspection & Defects, including X-Ray Inspection (9a)

C. S. BARRETT, SECTION EDITOR

Electrographic Analysis. A. GLAZUNOV. *Metal Progress,* Vol. 24, Oct. 1933, pages 58, 64. Alloying elements may be detected with an electrolyte-saturated paper pressed between the test piece and an Al plate and passing a current through the Al plate, saturated paper and test piece, from dry cells. Depending on the electrolyte used, a characteristic color reaction is obtained with various elements. WLC (9a)

Measuring Sharpness of Razor Blade Edges. PETER N. PETERS. *Metal Progress,* Vol. 24, Nov. 1933, pages 18-22. Describes the measurement of the intensity and roughness of corona discharge from blades under microscope as indication of the characteristics of the cutting edge. WLC (9a)

Testing of Lead Sheaths of Cables (Die Untersuchung der Bleimäntel von Kabeln). P. WIEGHARDT. *Electrotechnische Zeitschrift,* Vol. 55, Apr. 5, 1934, pages 339-340. A special etching process was developed which permits to observe whether the lead sheath pressed around a cable has no defect and is continuous. A few photographs illustrate how to recognize the various fillings of the press. The etching process is described. Ha (9a)

Clean Steel Should be Sounder than Dirty Steel. FEDERICO GIOLITTI. *Metal Progress,* Vol. 26, July 1934, pages 46-47. Difference in facts observed appears to be root of flake discussion. The writer calls attention to tendency of impurities to accumulate in joints of primary crystals where flakes occur. WLC (9a)

Some Notes on Defects and Fractures. WILLIAM BENNETT. *Engineering,* Vol. 137, Jan. 26, 1934, page 105. From paper read before the Society of Naval Architects and Marine Engineers, New York, Nov. 1933. Published in the Society's *Transactions,* Vol. 41, 1933, pages 66-86. Includes discussion. LFM (9a)

Radio-Active Methods in the Service of Chemical and Technical Problems (Radioaktiv Methoden im Dienste chemischer und technischer Probleme). H. KAEDING & N. RIEHL. *Angewandte Chemie,* Vol. 47, May 5, 1934, pages 263-270. Radio-active testing methods as they have been developed so far are reviewed and their particular application is described to investigate and determine the adsorption mechanism of coals, of the absolute surface of metals and the active surface of rare metals, for making visible grain boundaries and slag inclusions of metals, of surfaces of glasses and glass grit, to examine co-precipitation of minutest substances and to determine the quantity of the latter. Examples illustrate the methods. 33 references. Ha (9a)

Routine Disk Inspection in Quality Steel Manufacture. G. V. LUERSSEN. *Transactions American Society for Steel Treating,* Vol. 21, Apr. 1933, pages 343-353. Includes discussion. See "Mill Inspection by Deep Etch," *Metals & Alloys,* Vol. 5, June 1934, page MA 276. WLC (9a)

Danger of Fracture and X-ray Diffraction (Bruchgefahr und Röntgenstrahleninterferenz). P. LUDWIK & R. SCHEU. *Metallwirtschaft,* Vol. 13, April 13, 1934, pages 257-261. The width of X-ray diffraction rings of several annealed and heat treated carbon and alloy steels before and after static tensile and fatigue tests was determined photometrically. According to Regler fracture in any one metal occurs when the same width of diffraction ring is obtained regardless of previous treatment and the type of stressing, and that the danger of fracture of a stressed metal in service can be predicted by measuring this width. However the authors found that the increase in width at a fracture varies considerably according to the type of stressing and previous treatment. Noticeable increase in width probably occurs only after the elastic limit has been passed. Smaller increases in width were obtained in alternating stress tests than in tensile tests. In a Cr-Ni-W steel a greater width of diffraction ring was obtained by hardening and not stressing mechanically than by fracturing an annealed sample. The ring width has no direct relation to the stresses and deformations causing fracture and cannot be used as an indication of the danger of fracture. 20 references. CEM (9a)

Physical & Mechanical Testing (9b)

W. A. TUCKER, SECTION EDITOR

Simple Tests for Arc-Welded Joints. A. M. ROBERTS. *Engineering,* Vol. 137, Feb. 2, 1934, pages 112-116. These tests were devised by the Research Department of the Metropolitan-Vickers Electrical Company, Ltd. For the tensile and bend tests a drilled-notch form of tensile specimen was used. It was found that the effect of form on the tensile strength can be corrected for in unwelded plate specimens and correction factors were determined for this. The results of tests made on welded specimens failed to show any difference due to their form within the range investigated. The drilled-notch specimens break through the weld whereas radiused and parallel specimens often break through the parent plate. When fracture occurs through the plate, radiused specimens give neither the strength of the weld nor a true value for the strength of the plate. The cost and time of machining the drilled-notch specimens is less than 1/10 of that of the other forms of specimen investigated. Tables and graphs are given. LFM (9b)

Measurement of the Damping Capacity of Building Materials with Resonance Curves (Die Messung der Baustoffdämpfung durch Aufnahme der Resonanzkurve). W. KLEIN. *Ingenieurarchiv,* Vol. 5, Feb. 1934, pages 1-6. Mechanical vibrations excited in a material die away after cessation of excitation within shorter or longer time due to energy loss. The knowledge of these energy losses permits important conclusions on behavior of fatigue properties of materials. A method of determining damping capacity of materials is described. A cylindrical bar of the material to be tested is excited to longitudinal vibrations at the one end. In using constant amplitude of exciting force the amplitudes of vibrations at the other end of the test bar are measured in dependence on the frequency. GN (9b)

Apparatus for Magnifying the Loading Curve of Cast Irons (Appareil donnant à grande échelle le diagramme de l'essai statique des fontes). R. GUILLERY. *Revue de Métallurgie,* Vol. 31, May 1934, pages 195-197. Mechanical features of an apparatus for a sufficiently accurate determination of loading curves of cast iron under predetermined loads permitting determination of the modulus of elasticity. JDG (9b)

Axle Fatigue Inhibited by Truss-Graining. F. F. JOHNSON & T. W. LIPPERT. *Iron Age,* Vol. 133, Mar. 29, 1934, pages 19, 72, 74. Describes investigation conducted by the Spencer Mfg. Co., to determine the causes of axle failures and possible prevention. Fractures due to bending or impact are seldom due to inferior material, but usually start as fine surface cracks which gradually work toward the center. The problem was treated as a mechanical one instead of considering it as of chemical nature. Grain flow in outer section was so arranged that there was much greater resistance to start of incipient fatigue cracks. It also serves to give better descaling thereby resulting in deeper and more uniform hardening quench. The truss-graining process is done prior to final quench. Comparative tests were made only on bars of like chemical analysis and hardness. Tabulates results of one set of experiments. VSP (9b)

How the Hartford Steam Boiler Strain-Gage is Used in Safeguarding Engines. H. J. VAN DER EB. *Locomotive,* Vol. 40, Apr. 1934, pages 34-40. The instrument measures the elastic distortions occuring in crankshafts during each revolution. The principle of the measurement is explained, it consists in determining the distance between the cheeks or webs of a crankshaft which changes due to the stresses. The formula for calculating the stress from the reading is given and the application of the method illustrated by examples. Ha (9b)

Dependence of the Yield Point on the Stress Distribution and Material Tested (Abhängigkeit des Fliessbeginns von Spannungsverteilung und Werkstoff). E. SIEBEL & F. H. VIEREGGE. *Archiv für das Eisenhüttenwesen,* Vol. 7, June 1934, pages 679-682. Tensile, bend, torsion, and compression tests of different steels indicated that non-uniform stress distribution raised the upper yield point above the lower one, the rise in any steel being proportional to the difference between the maximum local stress and the average stress. For similar differential stress distribution the rise in the upper yield point was greater for softer than for harder steels. SE (9b)

Heat Treated Wire Tested Under Steady Load. H. F. MOORE. *Metal Progress,* Vol. 24, No. 3, Sept. 1933, pages 45-46. The writer reports certain tests of heat treated wire of the type used in certain bridge suspension cable under accurately controlled condition which failed to indicate cracks due to a creeping load. WLC (9b)

Disadvantages of the Spherical Form and Advantages of a Pyramidal Shape in the Brinell Hardness Test (Difetti della forma sferica e vantaggi di quella piramidale nella prova di durezza Brinell). C. MONTINI. *La Metallurgia Italiana,* Vol. 26, Mar. 1934, pages 172-179. A mathematical study of the hardness test, including a consideration of the impression made on the sample by the ball in the Brinell tester. It is shown that a pyramidal shape gives more precise values, especially for soft metals, such as copper and its alloys, AWC (9b)

New Amsler Testing Machines (Nouvelles Machines Système Amsler pour les Essais Mecaniques des Fontes). PIERRE BREUIL. *La Fonte,* Vol. 11, Jan.-Feb.-Mar. 1934, pages 407-418. A new Amsler testing machine, 3,000 kg. capacity, is used to make bending, hardness, shear, tensile, and compression tests. Another machine is of the swing through type impact tester up to 200 kg.-cm. WHS (9b)

Internal Stress. CHARLES S. BARRETT. *Metals & Alloys,* Vol. 5, June 1934, pages 131-135. Part I of a correlated abstract in 5 parts. Discusses mechanical methods of internal stress determination. 34 references. WLC (9b)

Hardness Test as Applied to Cast Iron (L'Essai de Dureté Appliqué à la Fonte). M. KAGAN. *La Fonderie Belge,* Vol. 3, Jan.-Feb. 1934, pages 12-21. Conclusions of the study are (1) skin hardness of a cast Fe casting is not quite uniform and often shows relatively important variations. (2) Hardness is affected not only by chemical composition but also by secondary factors. (3) P and its state have a great effect on hardness. (4) In a normal low P cast Fe hardness can be controlled by C and Si contents. (5) In normal high P cast Fe hardness can be controlled by P content and state. (6) Skin hardness can vary according to position of tested spot in relation with gate position, cast Fe temperature and cooling speed. (7) These variations seem to be smaller for low P cast Fe. (8) In particular cases, variation due to secondary factors can be as high as 20-30%. (9) In order to prevent discussion about what is called the hardness of a casting it is necessary (a) to define the portion of the skin where test should be made; (b) to speak of hardness limits and not of hardness measured by a single test; (c) to make therefore several tests on the same surface; (d) to admit a permissible hardness range over or under the correct number according to use of the casting. FR (9b)

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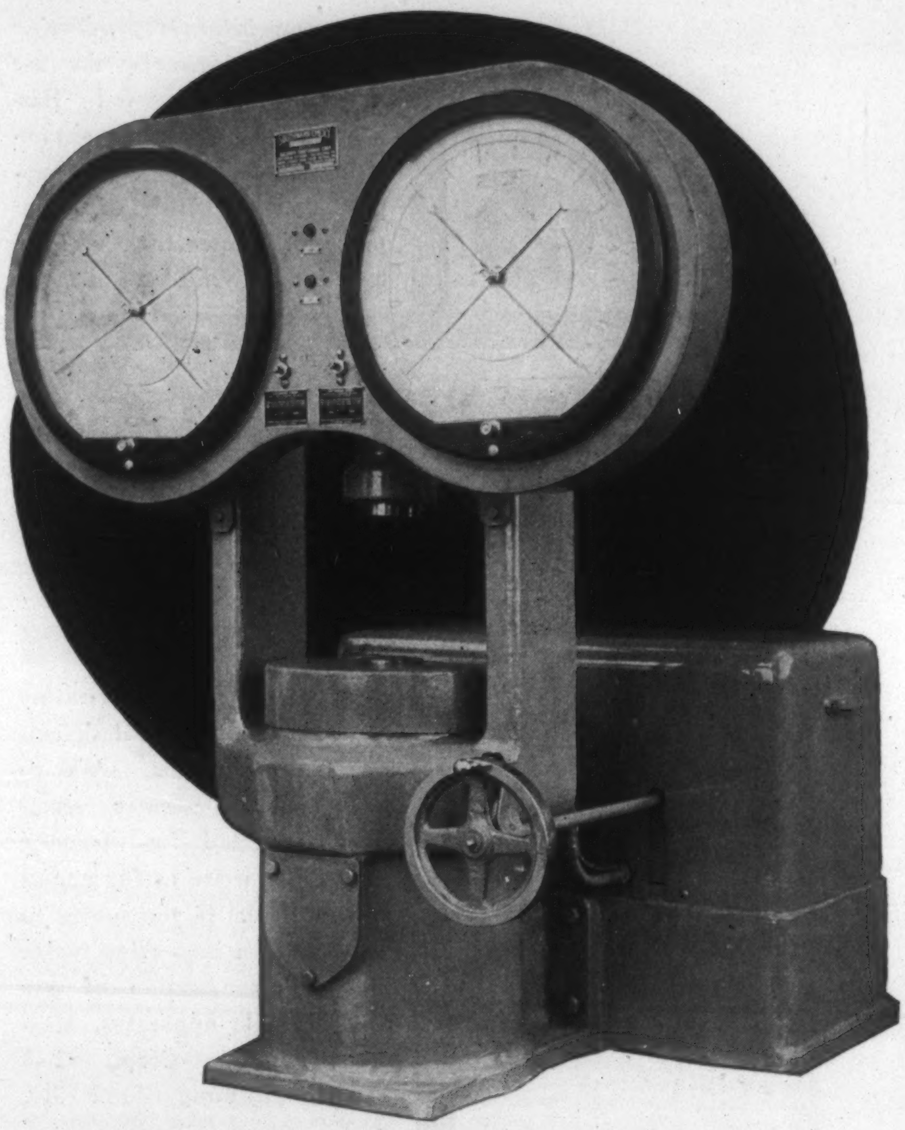

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Measurements of Surface Hardness and of Elastic Modulus of Materials by Means of P. Le Rolland Pendulum Method (La mesure de la dureté superficielle et du module d'élasticité des matériaux par la méthode de pendule de M. P. Le Rolland). *Génie Civil,* Mar. 1934, pages 224-226. A specimen in the shape of a round or square bar is fastened by its base while on its top is rigidly fixed a horizontal bar supporting on its ends 2 identical pendulums. When one is swung, the small displacements produced by it are passed through the bar and through the specimen to the second pendulum which begins to swing. Elastic properties of the sample bar are determined from this oscillating cycle. JDG (9b)

Apparatus to Determine Stresses in Large Castings and Forgings. RENE W. P. LEONHARDT. *Iron Age,* Vol. 133, Apr. 12, 1934, pages 20-23. Describes a special precision measuring machine developed in Germany to measure the swelling or contraction of a metal as machining removes stressed portions. Microscopes and telescopes form part of the equipment. Automatic temperature control is provided to maintain everything in testing room at constant temperature. VSP (9b)

French Aeronautical Research (La recherche aéronautique dans les milieux scientifiques français). PIERRE LÉGLISE. *L'Aéronautique,* Vol. 15, Nov. 1933, pages 258-260. Researches in progress under M. Ravilly at the Institute Polytechnique de l'Ouest include dynamic photoelasticity studies, in which a stroboscope is used to observe, by polarised light, the stresses produced in transparent test pieces under alternating impressed forces, investigations on the failure of valve springs, and alternating torsion tests at various temperatures on wires. JCC (9b)

Correlation of Test Bar and Casting. R. S. MACPHERRAN. Part of Symposium. Tests and Specifications for Cast Iron. *Transactions, American Foundrymen's Association,* Vol. 5, April 1934, pages 565-567. Strength of test bar does not necessarily represent the strength of the same iron when poured into a casting of any size. Bars of 3 diameters to represent various thickness of casting section aid in correlation. It has been suggested that test bars be used approximating the cooling rates of castings of simple shape by choosing a bar whose volume-surface area ratio is similar to that of the casting. 10 references. CEJ (9b)

Fatigue Testing (9c)

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in co-operation with the A.S.T.M. Research Committee on Fatigue of Metals.

The Mounting of Wire for Fatigue Testing. R. GOODACRE. *Engineering,* Vol. 137, May 4, 1934, pages 503-504. The Haigh machine was used for the tension tests and special machines were used for torsion and bending tests. Suitable ends must be attached to the wire which will not affect the properties and which will allow fracture to occur clear of the end connections. Low-melting point alloys were found suitable for use in the Haigh machine for non-ferrous materials and also for torsional and bending fatigue for all metals. Description and diagrams are given for the method of preparing ends of steel wires for test in the Haigh machine. The low-melting point alloy is not suitable for steel wire as the fatigue strength of it is low and the stresses required for the steel wire are relatively high. Even if very large ends are used, the wire is apt to slip out and the alloy tends to crack near the wire. LFM (9c)

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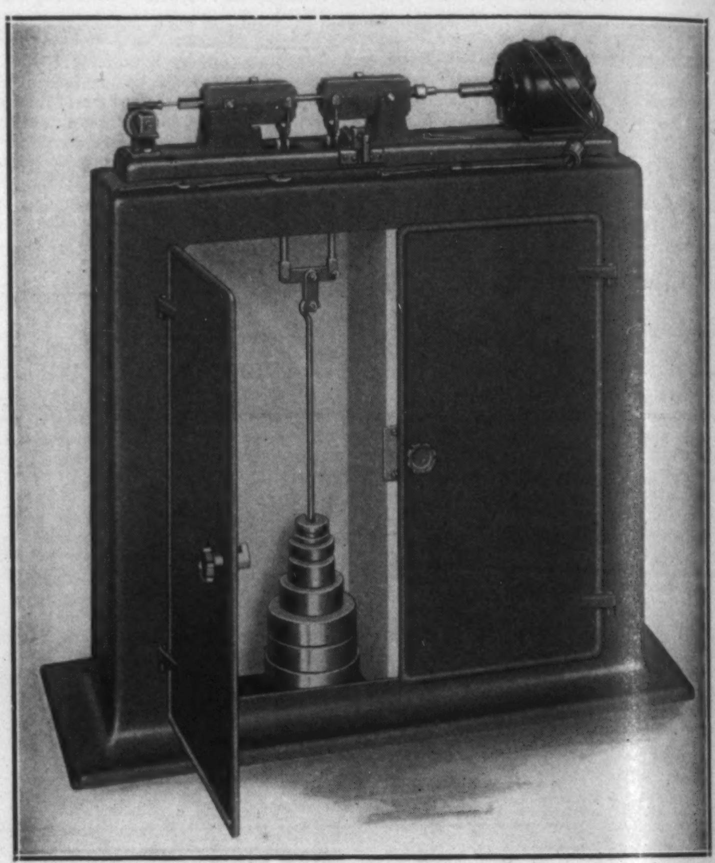

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METALLOGRAPHY (10)

J. S. MARSH, SECTION EDITOR

The System: Manganese-Tin-Mercury. Alan Newton Campbell & Herbert Dyson Carter. *Transactions Faraday Society,* Vol. 29, Dec. 1933, pages 1295-1300. Contains bibliography. The method of studying solubility isotherms of salt pairs in water to determine transition temperatures of the double salt was applied to alloy systems using Hg as solvent. A compound of Mn and Sn is formed, stable above 30° C., and of the formula Sn_5Mn_2 or Sn_3Mn, probably the former. Neither the components nor the compound form solid solutions with Hg or compounds similar to hydrates. PRK (10)

Investigations of Amorphous Metal Layers (Untersuchungen an amorphen Metallschichten). H. Zahn & J. Kramer. *Zeitschrift für Physik,* Vol. 86, No. 7/8, 1933, pages 413-420. Electrolytically deposited Sb and Pt are transformed into crystalline metal when heated above a certain temperature; this transformation temperature is a characteristic value independent of the manner of production of the amorphous modification. It was further found that very thin layers must be always more or less amorphous, as the number of free electrons in them decreases. The method of measuring the transformation as a condenser effect is described. 4 references. Ha (10)

Intersolubility of Lead and Copper and its Influence on the Quality of High-copper Lead-base Alloys (Sur la Miscibilité reciproque du Cuivre et du plomb et son Influence sur les Qualités des Alliages à Base de Plomb et a haute Teneur en Cuivre). A. Ricard & H. Ackermann. *Cuivre et Laiton,* Vol. 6, Feb. 28, 1933, pages 83-87. Many tests were made with Cu-Pb alloys and with additions of Sn and Ni in order to clarify the contradictory results of other investigations, some of which found total miscibility in any proportion, while others found a two-layer system. The conclusions from the new tests, illustrated by micrographs, confirmed the fact that alloys with high content of Cu and Pb can produce anti-friction metals with superior mechanical properties. These properties, however, cannot be obtained, as formerly in the white metals, solely by the effect of ordinary cold-working methods. The proper structure must have a certain coarseness of grain and rather be prepared while the metal is in the liquid state by suitable quenching; it cannot be further influenced after it has fully solidified, e.g., by cold-working. This is especially true if Sn and Ni be added, as these additions change the manner of solidification of Cu alloys and produce a fine-grained structure which is not very suitable for the purpose. Ha (10)

How to Determine the Precipitation of Carbides in 18-8 Stainless Steels (Comment décelar la précipitation des carbures dans les aciers inoxydables 18-8). M. Vialle & A. Van Den Bosch. *Revue de Métallurgie,* Vol. 31, Mar. 1934, pages 116-121. Delicate etching free from staining and pitting can be obtained by using a solution of 50 ml. perchloric acid (1.6), 50 ml. H_2O and 10 g. $CuSO_4$. It is used boiling and in 15 minutes sharply defines the areas of carbide precipitation in 18-8 type of steels. JDG (10)

Investigation of the Structure of Heavy Metal Products by Gamma-Rays (Die Strukturprüfung von Schwermetallerzeugnissen durch Gamma-Strahlung). M. Widemann. *Glasers Annalen,* Vol. 114, Mar. 15, 1934, pages 41-43; Apr. 1, 1934, pages 49-53. Paper discusses results of investigations on the structure of several heavy metals by means of the mesothorium α radiation. The limits of radiation capacity of x-rays are considered, the radiation capacity of a mesothorium compound is compared with that of an x-ray tube. GN (10)

Nital Etch for Macrostructure. H. O. Walp. *Metal Progress,* Vol. 25, Feb. 1934, page 38. 5% HNO_3 in alcohol for 5 min. followed by wiping and a few seconds in 10% HCl is used for revealing troostite spots in martensite, ferrite areas, tempering from improper grinding, and other macro-irregularities. WLC (10)

Late Developments in Microscopy. Francis F. Lucas. *Journal Franklin Institute,* Vol. 217, June 1934, pages 661-707. Discusses precision high power metallographic apparatus and monobromnapthalene objective of NA 1.60 recently corrected for the blue range of the spectrum and successfully used to show highly dispersed carbides in steel. FHC (10)

Press and Technique for Mounting Small Specimens. Daniel E. Krause & J. F. Oesterle. *Metal Progress,* Vol. 24, Nov. 1933, pages 33-35. Describes press and method of mounting small specimens in bakelite. WLC (10)

Photomicrographs and Their Interpretation—A Servant of Industry. A. Bramley. *Foundry Trade Journal,* Vol. 50, Jan. 11, 1934, page 29. An elementary discussion. OWE (10)

New Etching Reagent for the Phosphide Eutectic in Cast Iron. W. Keike & J. Gerlach. *Foundry Trade Journal,* Vol. 50, Feb. 8, 1934, page 107. Extended abstract of article which appeared in *Die Giesserei.* See *Metals & Alloys,* Vol. 5, June 1934, page MA 280. OWE (10)

Some Statistical Properties of an Annealed Alpha-Grain Aggregate, Part I. R. G. Johnston & W. G. Askew. *Metal Industry,* London, Vol. 44, Apr. 6, 1934, pages 363-365. Authors questioned fact that α-brasses show no directionality under the microscope when physical properties such as tensile strength are directional after annealing. The statistical method adopted was to select some feature of the alpha grain and to measure its orientation with respect to an arbitrary initial line drawn at random across the chosen field of crystals, and directionally plotted. In general, it was found that the preferred directions lay across, never along the direction of last rolling. The authors believe it is established that in cold-rolled and annealed α-brasses and similar alloys (1) that even an extreme over-annealing fails to eliminate definite and strong directionality; (2) that such orientations are correlated with the direction of rolling, the latter lying across the direction of cold work and never along it. HBG (10)

A Study of Banding in A Chromium-molybdenum Steel. E. R. Johnson & W. J. Buechling. *Transactions American Society for Metals,* Vol. 22, Mar. 1934, pages 249-270. A Cr-Mo steel of C 0.30%, Cr 0.955 and Mo 0.22% was studied for possible methods of eliminating banding. Results of series of tests showed that 6-7 hr. treatment at 2200° F. followed by reannealing at 1550° F. eliminated the banding in microstructure in bars. Tubing required less time but banding persisted on inside surface. Tubing made from band-free bars showed banding after several fabricating operations. High temperature treatment was necessary to remove banding from tubing. High hot-work temperatures aid in keeping banding to a minimum. Banding is apparently due to normal solidification process top portions of the ingot being better than bottom, high-temperature treatment improves the bottoms in physicals as well as microsructure. Bars show the usual directional properties even after banding has been removed by thermal treatment. WLC (10)

The Determination of Alumina in Steel (Die Bestimmung der Tonerde im Stahl). P. Klinger & H. Fucke. *Archiv für das Eisenhüttenwesen,* Vol. 7, May 1934 pages 615-625. A correlated abstract dealing with the various chemical and metallographic methods for determining and identifying alumina and other inclusions in steel. 41 references. SE (10)

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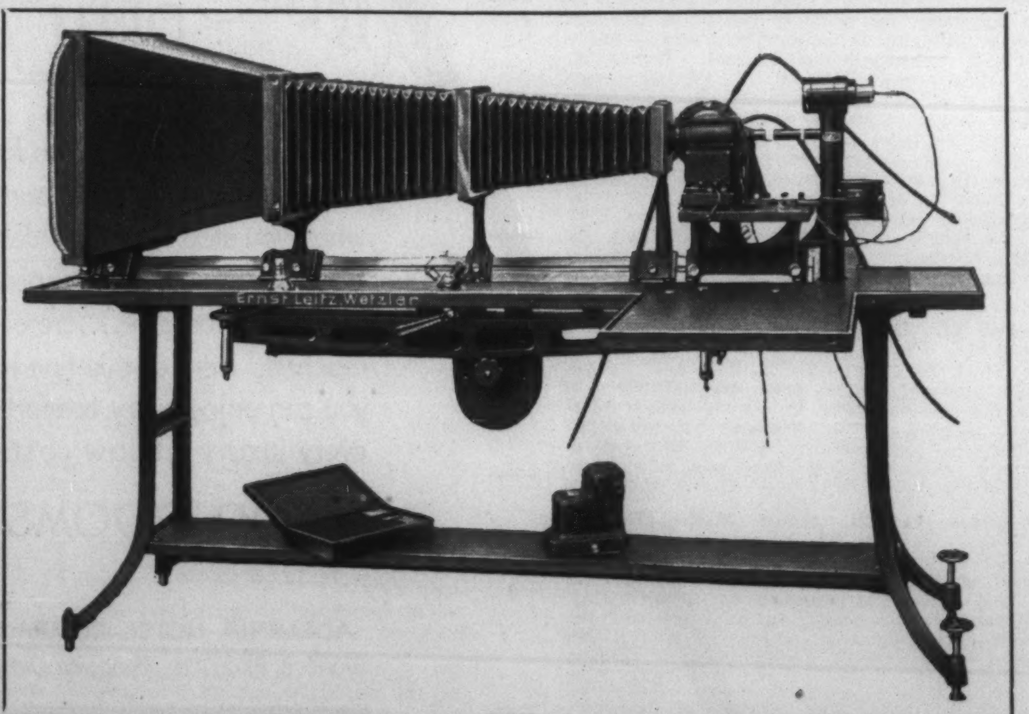

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Boundaries Between Iron, Steel and Cast Iron. A. M. Portevin. *Metal Progress,* Vol. 25, 1934, pages 51-52. The great number of borderline products produced of late years requires a more precise definition than formerly for these 3 materials. Portevin has adopted as criteria, eutectic, eutectoid and absence of either formation as indicating classification as cast iron, steel, or iron respectively. These criteria give very precise definitions and divide the Fe-C diagram into definite zones. WLC (10)

The Effect of Heat Treatment on the Form of the Sulphide in Steel (Der Einfluss einer Wärmebehandlung auf die Ausbildungsform des Schwefels im Stahl). A. Niedenthal & H. Bennek. *Archiv für das Eisenhüttenwesen,* Vol. 7, June 1934, pages 683-686. To determine whether sulphides in steel could be coalesced by high temperature heating, in order to overcome red shortness, 25 kg. induction-furnace ingots of various C and alloy steels, killed with 0.1% Al were vacuum annealed 4-1/2 hrs. at 800-1400° C. and water quenched. In the higher Mn steels, the original form of the sulphide was globular, in the lower Mn steels it was eutectic-like. Heating above 1200° C caused incipient fusion of the sulphides. At about 1100° C the globular sulphides remained unaffected, but the eutectic-like sulphides could be broken down somewhat and coalesced. Apparently at about 1100° C Fe has a certain solubility for S and this is raised by C. Forging tests indicated that heating high enough to coalesce eutectic sulphide, but not high enough to cause incipient fusion of the sulphides, improved the forgeability materially. Indications of the formation of both Cr and Mo sulphides were obtained. SE (10)

Periodic Structures in Metals and Alloys. L. Northcott. *Iron & Steel Institute, Advance Copy* No. 15, May 1934, 9 pages. The banding effect found in many steel ingots and castings is considered to be due to periodic crystallization. Similar structures were found in salts crystallized from water and in non-ferrous alloys containing impurities or small amounts of intentionally added elements. The effect is brought about by concentration of impurities in the layer of molten metal adjacent to the growing crystals. 6 references. JLG (10)

Determination of Oxide Inclusions in Iron by Potassium Ferrocyanide Prints (Die Ermittlung von Oxydeinschlüssen in Eisen durch Schliffabdrucke auf Blutlaugensalzpapier). O. Meyer & A. Walz. *Archiv für das Eisenhüttenwesen,* Vol. 7, Mar. 1934, pages 531-532. A series of prints on gelatin paper soaked with potassium ferrocyanide solution, of sections of high and low oxygen irons failed to bear out the suggestion of Niessner that such prints could be used to determine the content of oxide inclusions. The blue-colored spots formed on the prints are due to the reactions of the ferrocyanide solution with iron and not with iron oxide. The patterns obtained merely result from the fact that the various faces of the crystals in the section, and the crystal boundaries, react at different rates with the ferrocyanide solution. SE (10)

Effect of Nickel on the Transformation Point of Beta Brass and Heterogeneous Equilibria of Ternary System Cu-Zn-Ni. Keiji Yamaguchi & Kôzô Nakamura. *Bulletin Institute of Physical & Chemical Research, Tokyo,* Vol. 13, Feb. 1934, pages 89-108 (in Japanese) *Scientific Papers of the Institute of Physical and Chemical Research, Tokyo,* Vol. 23, Feb. 1934, pages 9-10. (In English). Thermal and electric measurements proved that the transformation of β brass near 460°C. rises gradually on adding Ni until the liquidus has been reached. The transformation heat increases with rising Zn and Ni contents. γ brass (Cu_5Zn_8) is isormorphous with the γ phase ($NiZn_3$) of the Ni-Zn system. For the composition range where the Cu and Ni contents exceed this γ phase no phase peculiar to a ternary system could be found. β' (brass) is that phase which forms a continuous solid solution with the β phase of the Ni-Zn system. In analogy to the binary brass, the ternary β phase cannot be retained in a metastable condition at room temperature by quenching from a high temperature. Distinguishing β from β' is not possible under the microscope. A transformation is not in disagreement with the phase rule. Some ternary α and β' solid solutions exhibit the characteristic Widmanstätten structure due to the change of mutual solubility in dependence on the temperature. The ternary equilibrium diagram is shown up to 70% Ni and 70% Zn. WH (10)

Transformation Kinetics of Austenite. III Magnetic Investigation of Self-hardening Steels (Zur Unwandlungskinetik des Austenits. III Magnetische Untersuchungen an selbsthärtenden Stählen). F. Wever & Heinrich Lange. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf,* Vol. 15, No. 41, 1933, pages 179-185. Experiments with Cr-Ni steels corroborated that there exist in these steels 3 temperature ranges in which the disintegration of austenite occurs according to different laws. The range of pearlite transformation lies at about 650°-500° C. The cementite formed in this range contains besides the α-Fe, almost the whole Cr content of the steel and has above room temperature no magnetic transformation. This pearlite range is bordered by a range of high inertia of transformation of austenite. The second, middle range, of the transformation begins below 450° C. In this range, and above 300° C., a carbide is formed, other than α-Fe, having a magnetic transformation and containing considerably less Cr than the cementite formed in the pearlite range, and 15% C. Whether the latter is bound as carbide or occurs elementary besides cementite is not as yet decided. Below 300° C., the formation of ferromagnietic carbide in the austenite transformation soon ceases. The 3rd transformation range, the formation of martensite, starts at a temperature determined by the amount of alloying material and C content. Above 150° C. this range is overlapped by the middle range. The law representing the temperature of martensite formation corresponds to the theoretical explanations of P. Weiss for the magnetic transformations. Methods and apparatus used are described. 9 references. Ha (10)

Alloys of Iron and Manganese—Part IX. Transformations and Heterogeneity in the Binary Alloys of Iron and Manganese. Francis M. Walters, Jr. *Transactions American Society for Steel Treating,* Vol. 2, Nov. 1933, pages 1002-1015. Dilatometric observation of Fe-Mn alloys shows large differences in composition to be produced by holding at temperature of alpha-gamma transformation. Restoration of homogeneity is obtained by treatment at 1000° C. (1830° F.). Discussion brings out that brittleness in 1.75% Mn steel is probably explained by exceeding the critical cooling rate; such alloys are very sluggish. WLC (10)

Alloys of Iron, Manganese and Carbon—Part VI. Factors Affecting Transformation in Binary Iron-Manganese Alloys. Francis M. Walters, Jr. *Transactions American Society for Steel Treating,* Vol. 21, Sept. 1933, pages 821-829. Dilatometric measurements of Fe-Mn alloys show that alpha-gamma transformation range on heating and cooling is increased by slow heating. These alloys are rendered more homogeneous by holding several hours near the solidus, as is indicated by narrowing of transformation ranges. In 16-30% Mn alloys, the epsilon phase is increased by deformation; transformation is virtually complete in 20% alloys. WLC (10)

Equilibria in the Iron-carbon System. Alfred Stansfield. *Transactions of the Royal Society of Canada,* Vol. 27, Sec. III, May, 1933, pages 177-178. Article, accompanied by 1 diagram, describing method for obtaining equilibria in the iron-carbon system, which consists in slowly passing a carefully dried mixture of CO and CO_2 over fine turnings of the iron-carbon alloy, which are closely packed in a silica tube and heated to the desired temperature. Note is made of any change in composition of the gas. No attempt is made to allow enough time for complete equilibrium to be attained, but in a subsequent test a different gas mixture is used, the composition of which will be changed in the opposite direction when passed over the same alloy at the same temperature. In this way position of the equilibrium can be determined within definite limits. OWE (10)

The Yield Strength of Non-ferrous Metals (Die Fliessgrenze von Nichteisenmetallen). P. Schoenmaker. *Recueil de Travaux Chimiques des Pays-Bas,* Vol. 51, June 15, 1932, pages 598-604. Cold working of metals can bring about elastic and plastic deformation; in the former range, all metals show exact proportionality between stress and elongation. In the plastic range, however, the metals behave differently. In some metals, as Fe and low—C steels, a permanent deformation takes place suddenly, just a little above the elastic limit. The metal "flows"; the stress at this point is called the yield strength. Other metals show a less sudden transition from the elastic to the plastic range. An actual flow limit, as in Fe, does not exist; elongation increases regularly with tension, but in order to facilitate calculations for practical purposes, yield strength is called that tension or stress at which the permanent elongation amounts to 0.2%. A distinct difference, therefore, exists in the flow limit for Fe where it means a characteristic material constant which is connected with a discontinuous change of physical properties, while in other metals it means only an arbitrary magnitude assumed for practical purposes. Curves at different temperatures and for different metals are reproduced. The different behavior of ferrous and non-ferrous metals is explained by changes of inner structure due to mechanical loads. Ha (10)

Crystallization between Surfaces the Structures of which are as much as possible in Equilibrium (Kristallisationen zwischen möglichst weitgehend im Strukturgleichgewicht befindlichen Oberflächen). F. Sauerwald & L. Holub. *Zeitschrift für Elektrochemie,* Vol. 39, Sept. 1933, pages 750-753. If substances are pressed from metal powders, internal stresses are generated which could be made visible in X-ray photographs, because the Kα-doublets became indistinct. Crystal growth could be observed at 900°, but not at 500° C., between non-stressed surfaces of Cu monocrystals when the surfaces were in structural equilibrium. This crystal growth occurs at higher temperatures than those of recrystallization of mechanically deformed crystals, and is due probably not to a formation of crystal germs but is a dislocation of the grain boundaries. The experiments permitted the conclusion that the tendency to crystallize is weaker in aggregates, the monocrystals of which originate in the melt, than in aggregates the monocrystals of which are produced by reduction from solid oxides. Ha (10)

X-Ray Investigation of the Aging Effect in Quenched Carbon Steels. Zenji Nishiyama. *Kinzoku no Kenkyu.* Vol. 11, Feb. 1934, pages 57-60. In Japanese. *Science Reports Tohoku University,* Vol. 22, 1933, pages 565-569. In English. Steel specimens of 0.81, 0.93, 1.11 and 1.31% C were quenched in water from γ region. The surface of the specimen was then dissolved by a 15% HNO_3 solution for half an hour. Then it was kept at 59°C in the constant-temperature bath containing boiling chloroform. X-ray diffraction patterns of the specimens aged for different times were taken and compared. The X-ray camera was of Seemann-Bohlin type of 17 cm. diameter and the anti-cathode was cobalt. The interference lines (101) and (110) of tetragonal martensite were found separated and diffused in the "as-quenched" specimen. But with the time of aging at 59° C., the two lines draw nearer to each other to become a single line. The aging of one year at room temperature correspond to that of 70 hours at 59°C. Thus tetragonal martensite transforms very slowly into the harder cubic one. KT (10)

The Curie Point for Thin Layers of Electro-deposited Nickel (Le Point Ferromagnétique de Curie pour des Couches Minces de Nickel, Deposées Électrolytiquement). St. Procopin & T. Farcas. *Comptes Rendus,* Vol. 198, June 4, 1934, pages 1983-1985. Curie point for Ni at 358° C. is constant except for cold-worked metal and also for Ni subjected to certain types of AC fields. Thin layer of electro-deposited Ni showed lowering of 17° C. of Curie point. Experiment confirms Heisenberg's theory of ferromagnetism. FHC (10)

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Interconversion of Atomic and Weight Percentages J. S. Marsh. *Metals & Alloys,* Vol. 5, Mar. 1934, page 48. A new mathematical short-cut for conversion of atomic and weight percentages. WLC (10)

Effect of Elastic Elongation of Ferromagnetic Material on the Curie Point (Einfluss der elastischen Ausdehnung von ferromagnetischem Material auf den Curie Punka). M. N. Michejew. *Physikalische Zeitschrift der Sowjetunion,* Vol. 3, No. 4, 1933, pages 393-398. Experiments on a 30/70 CuNi alloy at various loads up to 14.8 kg./mm.^{2} yielded that the Curie point (52°C. + 1°) is not affected by elastic stressing. EF (10)

X-Ray Investigations of Hydrogen-charged Palladium-Gold Alloys (Roentgenographische Untersuchung von wasserstoffbeladenen Palladium-Gold-Legierungen). H. Mundt. *Annalen der Physik,* Series 5, Vol. 19, Apr. 1934, pages 721-732. Pd-Au alloys behave similarly to Pd-Ag alloys as regards absorption of H. The lattice structure changes with absorption of H; the magnitude of the changes was determined for various compositions of Pd-Au. 10 references. Ha (10)

Equilibrium Diagrams of Alloys Formed of Two Alkaline Metals: Sodium-rubidium Alloys (Diagrammes de solidification des alliages formés par deux métaux alcalins: alliages sodium-rubidium). E. Rinck. *Comptes Rendus.* Vol. 197, Dec. 4, 1933, pages 1404-1406. An article accompanied by 1 diagram showing that the Na-Rb system is eutectiferous in character, the eutectic containing approximately 75 atomic percent of Rb and freezing at —4.5° C. OWE (10)

The Structure of Oxide Films on Nickel. G. D. Preston. *London, Edinburgh & Dublin Philosophical Magazine & Journal of Science,* Vol. 17, Feb. 1934, pages 466-470. Films of nickel oxide on the surface of a Ni sheet showed a crystal structure, when examined by the electron-diffraction method, identical with massive NiO having a rock-salt type of lattice of approximately 4.10 A. U. parameter. Ha (10)

Displacement of the Curie Point with Concentration in Iron-nickel-tungsten (or molybdenum) Austenites (Déplacement du point de Curie avec la concentration dans les austenites fer-nickel-tungstène (ou molybdène)). A. Portevin, E. Pretet & H. Jolivet. *Comptes Rendus,* Vol. 198, Mar. 19, 1934, pages 1141-1144. The authors show by means of a diagram that by quenching an alloy containing 0.07% C, less than 0.3% Mn, some Si, 26.6% Ni, and 24.0% W, at temperatures varying from 700 to 1400° C. (the alloy having first been brought into equilibrium at these temperatures), the Curie point may be depressed from 225° C. to room temperature. At the same time the magnitude of the point is reduced. By means of other curves the authors show the effect of nickel content on the Curie point of alloys of constant (25%) W content as quenched from 900° C. and as chill cast. OWE (10)

Effect of Nickel Additions on Solubility and Precipitation in the System Silver-Copper (Über den Einfluss eines Nickel-zusatzes auf de Löslichkeit und den Ausscheidungsverlauf im System Silber-Kupfer). H. Pfister & P. Wiest. *Metallwirtschaft,* May 4, 1934, pages 317-320. Cu alloys containing 1% Ni and from 1 to 10% Ag were investigated. In the preparation of the samples very long annealing periods were required to homogenize them. The solubility of Ag in Cu is slightly lowered by the addition of 1% Ni, the difference increasing above 600° C. The precipitation of Ag from recrystallized material is shown by lattice constant—time curves for various temperatures. The curves show a gradual reduction in the lattice constant. Hardness—time curves at constant temperature show three successive maxima. Curves of "critical dispersion" are given for the hardness maxima. The hardness maxima and the precipitation process of polycrystalline Cu-Ag-Ni alloys are similar to those of binary Cu-Ag single crystals, while polycrystalline Cu-Ag alloys have only one maximum in the hardness—time curves. Apparently a stronger mosaic structure is formed in recrystallized than in cast alloys. The addition of Ni to Cu-Ag alloys has the effect of enlarging the coherent extent of the mosaic structure. 13 references. CEM (10)

Magnetism of Rhenium in the Metallic and Heptavalent States (Sur la Magnéto—Chimie du Rhénium Mètallique et Rhénium Heptavalent). Nicolas Perakis & Léandre Capatos. *Comptes Rendus,* Vol. 198, May 28, 1934 pages 1905-1907. Paramagnetism of metallic rhenium is independent of the temperature in the range—79° C. to 20° C. and the susceptibility for this range is given as 0.369×10^{-6}. FHC (10)

Physical-property Changes of a Polycrystal During Crystal Recovery (Die Änderung der Eigenschaften eines Polykristalls bei der Erholung). M. O. Kornfeld. *Physikalische Zeitschrift der Sowjetunion,* Vol. 4, 1933, pages 668-674. The recovery phenomena lead to a relatively stable state distinguished by a higher yield point as compared with the original material. The gain of the yield point value is ascribed to lattice distortions not eliminated by the recovery process. Annealing of deformed polycrystalline Al in the temperature range of pure crystal recovery does not restore the initial physicals. Laue photographs yielded that there is no appreciable displacements at the crystal boundaries during crystal recovery. The experimenters conclude that the physical property changes during recovery are closely connected with phenomena taking place inside of the grains. EF (10)

Allotropic Change in Single Crystals of Tin (Die Umwandlung des weissen Zinns ins Graue an Monokristallen). A. Komar & B. Lasarew. *Physikalische Zeitschrift der Sowjetunion,* Vol. 4, 1933, pages 130-131. The transformation of white Sn into the gray modification takes place at the same rate in polycrystals as in plastically deformed single crystals. In the case of an "undisturbed" single crystal the transformation speed is 200-300 times as large as with polycrystalline material with reference to —30°C. At this temperature the transformation speed of the reaction white Sn⟶gray Sn reaches a maximum value with ordinary Sn. EF (10)

The Iron Corner of the System Iron-Manganese-Chromium (Die Eisenecke des Systems Eisen-Mangan-Chrom). W. Köster. *Archiv für das Eisenhüttenwesen,* Vol. 7. June 1934, pages 687-688. The constitution of the Fe-Mn-Cr alloys up to 40% Mn and 30% Cr was studied. As solid phases only α and γ solid solutions appeared. Up to 12% Cr there is not much change from the constitution of the binary Fe-Mn alloys. Between 12 and 28% Cr the alloys consist of $\alpha + \gamma$. SE (10)

Relation between Solution Velocity, Solvent and Lattice Forces of Single Crystals of Copper (Ueber den Zusammenhang zwischen Lösungsgeschwindigkeit, Lösungsmittel und Gitterkräften bei Kupfereinkristallen). R. Glauner. *Paper Third Corrosion Congress Verein deutscher Ingenieure, Verein deutscher Eisenhüttenleute, Deutsche Gesellschaft für Metallkunde und Verein deutscher Chemiker,* Nov. 14, 1933, Berlin. Mimeographed report, pages 3-4. See *Metals & Alloys,* Vol. 5, June 1934, page MA 296. GN (10)

Solubility of Carbon in Iron-Manganese-Silicon Alloys. C. H. Herty, Jr. & M. B. Royer. *United States Bureau of Mines Report of Investigations* No. 3230, May 1934, 22 pages. C solubility at 1300°, 1500° and 1700° is given for 90 alloys containing Mn 0-80%, Fe 20-100%, and Si 0-45% (5% increments) and for 51 alloys containing Mn 0-2.5% (0.5% increments), Si 0-10.0% (0.5-2.0% increments), and Fe 87.5-100% (0.5-2.0% increments). The area bounded by 10:1 and 4:1 Mn-Si ratios is divided into 3 regions, representing 3 possible methods of deoxidation,—ladle, furnace, and an intermediate range in which the alloy may be used in either manner. C content within the furnace-deoxidizer range varies from 4.32% at 90% Fe, 8% Mn and 2% Si to 3.02% C at 50% Fe, 40% Mn and 10% Si at 1300°. In the intermediate range, C lies between 4.35% at 50% Fe, 45% Mn and 5% Si and 2.40% C at 25% Fe, 60% Mn and 15% Si. In the ladle-deoxider range, C varies from 4.57% at 34% Fe, 60% Mn, 6% Si to 2.15% C at 80% Mn, 20% Si and Fe 0. Mn, having a carbide-stabilizing action, exerts an increasing solubility effect when increasing amounts of Mn are added to Fe. Si in relatively small amounts added to Fe exerts a marked graphite decomposition effect until at 50% Si and 50% Fe, less than 0.1% C remains in solution. AHE (10)

Measurments by Means of Liquid Helium. XXII. Resistance of Metals, Alloys, and Compounds (Messungen mit Hilfe von flüssigem Helium. XXII. Widerstand von Metallen, Legierungen und Verbindungen). W. Meissner, H. Franz & H. Westerhoff. *Wissenschaftliche Abhandlungen der Physikalisch-Technischen Reichsanstalt, Berlin,* Vol. 16, No. 1, 1933, pages 207-233. See *Metals & Alloys,* Vol. 5, May 1934, page MA 214. EF (10)

Quality Control of Aluminum-bronze Castings (Controle de la Qualité des Moulages de Bronze d'Aluminium). Ch. Meigh. *Usine,* Vol. 43, Mar. 22, 1934, page 29. Owing to the fact that the kind of mold and that cooling rate has great effect on the properties of Cu-Al alloys, it is suggested that samples of castings be subjected to micrographic examination, because the relation existing between structure and mechanical properties, in particular endurance, supplies reliable information on the properties of the respective samples. Several examples of different alloys are given to illustrate how the method can be of help to the foundry. Ha (10)

A Study of the Influence of an Electric Field on the Potential at a Metal-solution Interface. H. K. McClain & H. V. Tartar. *Journal of Physical Chemistry,* Vol. 38, Feb. 1934, pages 161-170. Effect of an electric field of moderate strength on the potentials of Au and Pt against several solutions has been investigated. Results prove validity of one fundamental assumption in the treatment of cataphoresis; namely, that the charge distribution in the double layer is unaffected by an applied field of the strength used in cataphoresis experiments. 27 references. EF (10)

Crystal Structure and ferromagnetism of Mn-Al-Cu alloys (Kristallstruktur und Ferromagnetismus der Mn-Al-Cu-Legierungen). O. Heusler. *Zeitschrift für Metallkunde,* Vol. 25, Nov. 1933, pages 274-278. The ferromagnetism of Heusler alloys is associated with the ternary β phase; this phase is unstable at room temperature and aging is possible, leading to changed values in the magnetic (and other) properties. Freshly quenched alloys falling within the composition range of the β phase show superstructure lines. On aging the only change is a variation in the relative intensities of the superstructure lines. The superstructure is one in which (for composition Cu_2MnAl) two face-centered cubic lattices of Al and Mn, respectively, interpenetrate to form a NaCl lattice, and a separate simple cubic lattice of Cu atoms occupied a body centered position in this lattice, giving a threefold body-centered cubic superstructure. These three partial lattices interchange atoms, lowering the order of perfection of the superstructure; calculation shows the freshly quenched alloy to be an imperfect superstructure and the aged alloy to be perfect. This change in atom distribution is accompanied by changes in electric conductivity and magnetic behavior, as shown in graphs. It is concluded that each change from perfection, either by a redistribution of atoms in Cu_2MnAl or by the introduction of new atoms (changing composition) the magnetization is decreased and the Curie point lowered. With discussion. See also *Metals & Alloys,* Vol. 5, June 1934, page MA 280. RFM (10)

The Effect of Stress on the Transformation Temperature of Iron. J. L. Holmquist. *Metals & Alloys,* Vol. 5, June 1934, pages 136-138. Theoretical treatment by thermodynamic calculations of the effect of stress upon transformation temperature in conclusion that stress plays minor part in displacements of transformation temperatures. 5 references WLC (10)

Observations on the Metallographic Etching of Platinum (Beobachtungen bei der metallographischen Aetzung von Platin). A. Jedele. *Metallwirtschaft,* Vol. 13, May 11, 1934, pages 335-337. When Pt or Pt alloys are polished for metallographic examination and etched in aqua regia the crystal structure does not become visible but a uniform gray surface is obtained. If the surface of the Pt is sufficiently smooth, as is sometimes the case with laboratory crucibles and dishes, that it can be examined without the usual polishing process, then etching in aqua regia develops a distinctly visible crystal structure. Polishing seems to form a surface layer on the Pt which hides the structure of the crystals lying below it. Experiments proved that by heating the Pt for 5 or 10 min. to recrystallize this surface layer, follower by etching in aqua regia, a structure could be developed on polished specimens. It is necessary to heat above 650°C. and 900° to 1200° is better. However the structure so obtained represents only the recrystallized surface layer and may not be the same as the structure of the metal beneath. The recently published process by F. Beck of electrolytic etching in molten NaC1 discloses a structure because the surface is recrystallized by the molten salt. It also represents the surface only. CEM (10)

PROPERTIES OF METAL & ALLOYS (11)

Electric Resistance Materials (Über elektrische Widerstandsmaterialien). Alfred Schulze. *Metallwirtschaft,* Vol. 13, May 25, 1934. pages 369-372. For precision resistances manganin, consisting of 86% Cu, 12% Mn and 2% Ni, is mostly used. The variation of resistance with temperature and other physical properties of manganin are given. For commercial rheostats and heating elements three groups of alloys, according to the operating temperature range, are used. The first group consists of the Cu alloys, nickel silver, nickelin, constantan and isabellin, the second of Cr-Ni and Cr-Ni-Fe alloys, and the third of Fe-Cr-Al and Fe-Cr-Al-Co alloys. The chemical compositions, specific resistance, resistance-temperature coefficient, coefficient of linear expansion, specific heat, specific gravity, melting point, and maximum working temperature of these alloys are given and their use discussed. CEM (11)

Studies on Cast Red Brass for the Establishment of a Basic Classification of Non-Ferrous Ingot Metals for Specification Purposes. C. M. Saeger, Jr. *Metal Industry,* London, Vol. 44. June 15, 1934, pages 607-609; June 22, 1934, pages 631-634, June 29, 1934, pages 654-656, 659. (A. F. A. Exchange paper presented at the Annual Conference of the Institute of British Foundrymen held at Manchester June 5-7, 1934.) A study of the effect of pouring temperature and of additions of sulphur or iron on the physical properties of red brass (85-5-5-5). Data were obtained on virgin metal, remelted metal, and remelted metal with additions of sulphur or iron. Macrographs and micrographs are included to account for the change in physical properties at high pouring temperatures. Shrinkage and running properties of the alloy are included. HBG (11)

Non-Ferrous (11a)

A. J. PHILLIPS, SECTION EDITOR

On the Specific Heats of Tungsten, Molybdenum, and Copper. H. L. Bronson, H. M. Chisholm & S. M. Dockerty. *Canadian Journal of Research,* Vol. 8, Mar. 1933, pages 282-303. The authors describe a new type of all-copper adiabatic calorimeter from which water has been completely eliminated. Two methods were used in determining the specific heats: (1) the usual "method of mixtures," (2) the specific heat of copper was also determined by heating the calorimeter electrically. Results of the experiments could be expressed empirically, as follows:

Tungsten ....$C_p = 0.03199 + 0.00000328T - 129T^2$
Molybdenum ....$C_p = 0.06069 + 0.0000120T - 361T^2$
Copper ....$C_p = 0.09292 + 0.0000136T - 452T^2$

where the unit of heat is the 20-degree calorie and T is absolute temperature. OWE (11a)

Recrystallization and Strengthening of Aluminum in Plastic Torsion (Rekristallisation und Verfestigung von Aluminium bei plastischer Torsion.) A. E. van Arkel & M. G. van Bruggen. *Zeitschrift für Physik,* Vol. 80, Feb. 23, 1933, pages 804-812. Torsion tests made with small Al-rods of fine grain showed torsion to be a partially reversible phenomenon which produces a maximum crystal size upon recrystallization under alternating torsion of a definite value. This maximum coincides with a minimum of strengthening in the direction of the axis of torsion. Polycrystalline and monocrystalline Al-rods show an elastic after-effect, but some monocrystals show this after effect only under torsion, due, very likely, to a different orientation. Tests and results are described in detail. Ha (11a)

Causes of Porosity in Non-Ferrous Castings. J. H. Cheetham. *Iron Age,* Vol. 133, Feb. 1, 1934, pages 22-24. **Preventing Porosity in Non-Ferrous Castings.** *Iron Age,* Vol. 133, Feb. 8, 1934, pages 21-24; Feb. 15, pages 28-30, 72. Describes appearance of defects which cause porosity. Considers the causes of oxidized metal, gasified metal, eutectic segregation and methods used to purify and harden the metal. Method of promoting fluidity and fluxes are also discussed. In following installments deals with deoxidizing and degasifying agents such as P, B, Zn, Mn, Si, soda ash, glass, borax, etc., and methods to be used to promote density in castings. Based on years operation porosity troubles should be charged as follows:

2% to metal storage. 18% to furnace operation. 65% to skimmer. 15% to molder. VSP (11a)

Vacuum Melted Beryllium Alloys (Vakuum geschmolzene Beryllium-Legierungen). W. Hessenbruch. *Heracus Vacuumschmelze,* 10th Anniversary Volume, 1933, pages 201-232. For avoidance of loss of Be in melting and for securing hardenable alloys with reproducible properties, melting in vacuum is to be preferred to melting under salt layers. The properties of numerous Be alloys with Ci, Ni, Co and mixtures of these after vacuum melting have been determined together with the effect thereon of heat-treatment. The cold-worked and hardened 2.5% Be-Cu alloy has yield point (σ_E) 107 kg./mm.,^{2} tensile strength (σ_B), 123.3 kg./mm.,^{2} elongation (E) 5.7% Brinell hardness (H_B) 350, and notched impact strength (I_N) 0.81 m.-kg./cm.^{2} The corresponding values for the similarly treated 1.7% Be-Ni alloy are 150, 182.5, 8.3, 460 and 4.47. Workable Be-Co alloys can be obtained only by addition of more than 8% Fe, to convert the Co from the hexagonal into the cubic form; for the 2:8:90 Be-Fe-Co alloy after quenching from 1000° C. and tempering at 400°-450° C. for 8 hrs. H_B = more than 600. The solubility of Be in Cu, Co, Ni and Fe is reduced by addition of Mo, W, Cr and Mn, and hence precipitation-hardening can be obtained with very little Be; thus addition of 0.6-1% Be to contracid (Ni 61, Cr 15, Fe 15, Mn 2, Mo 7%) results in the following changes in properties; quenched from 100°, σ_E 41.7, σ_B 88, E 29, H_B 195, I_N 13.9; subsequently cold-rolled 30% and tempered at 450 for 6 hrs., σ_E 118, σ_B 129, E 7.9, H_B 430, I_N 2.8. TAddition of 1-1.5% Be to 80:20 Ni-Cr and 65:15:20 Ni-Cr-Fe induces precipitation-hardening. An alloy of Co 34, Fe 50, Cr 15 and Be 1% has H_B 225 after quenching from 1000°, 470 after cold-rolling to 50% reduction, and 700 after subsequent tempering at 450°. Alloys of Cu with 1% Be and 5% Mn or Ag or 3% Si can be heat-treated to obtain H_B 300, and Cu alloys with 1% Be and 3% Ti to obtain H_B 370. (11a)

Susceptibility for Hot-Deformation of Binary and Complex Copper-Zinc Alloys (Ueber das Warmverformungsvermögen binärer und komplexer Kupfer-Zink-Legierungen). P Roentgen & W. Donike. *Zeitschrift Verein deutscher Ingenieure* Vol. 78, Feb. 17, 1934, pages 220-223. Previous investigations into the behavior of brass alloys under hot deformation are reviewed; the influence of Pb, P, Mn, Fe, Ni and Sn on hot-deformation is examined and the results checked with the effects of Pb+A1, P+A1, Pb+Ni and P+Ni. Less than .1% Pb is soluble in the α and β solid solutions of Cu-Zn alloys. Cracks occur in hot-rolling even with very low Pb content. The behavior is somewhat better under hot-pressing where Pb contents from 2 to % may be admissible according to composition of alloy. The P content also must not be higher than 0.1% otherwise hot-rolling is impossible as cracking takes place. Mn up to 5% exerts no harmful influence in hot-rolling, no cracks appeared; the same was the case for A1 up to 5%. Fe is very limitedly soluble in α—and β—brass, at high Fe contents Fe is segregated in spherical particles in large aggregations. No cracks appeared under hot-deformation. Ni had no harmful influence. The solubility of Sn in β-brass increases with increasing temperature, but below 600° C. the alloys rich in Sn precipitate brittle γ-crystals. Sn up to 5% does not deteriorate the good hot-deformability of Cu-Zn alloys; alloys with higher contents of γ-solid solutions can not however be deformed below 500° C. In general, pure brasses with any amount of α-and β-solid solutions can be hot-deformed without cracking. Pb, P and 0 are injurious in very small amounts, A1, Fe, Mn, Ni and Sn only in excess of 5%. The latter elements, with the exception of Fe, form, at the deformation temperature, solid solutions which explains why the good hot-deformability of pure brasses remains. Fe appears as foreign body which, however, is plastic and segregated in spherical shape, and therefore, does not disturb the cohesion of crystals. The harmful elements, on the other hand, are segregated as brittle film between the crystals and thus reduce cohesion. 16 references. Ha (11a)

Bronzes with High Lead Content. (Hochbleihaltige Bronzen). J. Wecker. *Die Giesserei,* Vol. 20, Mar. 17, 1933, pages 112-113. In Pb-bronzes consisting mainly of Cu, Pb and Sn, the latter is an inconvenient component as it prevents using much Pb. 2 1/2% Ni instead of Sn permits Cu and Pb to mix in very wide limits, but is too expensive. Combinations of Cu-Pb-Ni-Sn, Cu-Pb-Ni-Mn and Cu-Pb-Ni-Mn-Sn were investigated. While 4% Sn was the upper limit for which 30% Pb can be kept in the alloy, 5% Ni could hold 40% Pb without segregation and with 7% Mn hardly any segregation takes place. If Mn and Sn are used together the sum of both should not exceed 7% as otherwise segregation begins for more than 30% Pb. The solidification interval decreases with increasing content of Mn, and the distribution of Pb is much finer in the Mn-containing alloys than in those containing Sn. Using Mn instead of Sn eliminates entirely the extremely injurious inclusions of stannic oxide crystals. Co additions to Cu-Pb are not favorable. As increases hardness and impact strength but deteriorates bearing properties. P. has no deleterious influence, nor has a treatment of the melt with alkaline earths. Mn can be used successfully in the form of ferromanganese (90%). The strength of the alloy with 30% Pb, 5% Mn, 2% Ni was 13-15 kg./mm.^{2} with 10-13% elongation. Linear shrinking was 1.29%, the density 9. Ha (11a)

Dimensional Changes in Die Casting Alloys. Metastable Beta Phase in Al-Zn Alloys. R. G. Kennedy, Jr. *Metals & Alloys,* Vol. 5, May 1934 pages 106-109, 112; June 1934, pages 124-126. Alloys made from very pure Al and Zn were studied for properties of unstable β phase. Heat evolution, contraction and temporary increase in hardness accompany decomposition of β phase into finely divided mixture of α and γ solid solutions. 85% Zn containing both α and β constituents at quenching temperature decomposes more rapidly than 78.3% Zn alloy, all β phase at quenching temperature. Alloys made of commercial materials decompose slower than those made of very pure metals. At low temperatures, lowering the aging temperature inhibits decomposition. While the addition of Mg does not prevent change it compensates partially for contraction. WLC (11a)

Adnic, A White Metal Alloy for Corrosion-Resistance and for Moderate Temperature Heat-Resistance. William B. Price. *Metals & Alloys,* Vol. 5, Apr. 1934, pages 77-81. Adnic is essentially 70% Cu, 29% Ni and 1% Sn. Hard rolled 1/2 in. rod has tensile strength of 113,200 lbs./in.^{2} and an elastic limit of 85,000 lbs./in.^{2} A 1 in. hexagonal rod has a tensile strength of 64,500 lbs./in.^{2} and elastic limit of 35,600 lbs./in.^{2} Hot working temperatures are 850° and 1100° C. Graphs show properties at elevated temperatures hold up well to 500° C. Microstructures, physical properties of the cold worked metal and corrosion test data are given. Creep tests show a sharp fall in load carrying capacity from 600°-800° F. but its load carrying capacity at 800° F. is somewhat better than C steel at 1000° F. WLC (11a)

Recent Developments in Lead. *Metallurgia*, Vol. 10, May 1934, pages 1-4. Compares properties of Pb containing small amount of Te with ordinary Pb. Te raises recrystallization temperature and prevents grain growth in ordinary service. JLG (11a)

Metallic Calcium and Its Uses (Metallisches Kalzium und seine Verwendung). Freitag. *Automobiltechnische Zeitschrift*, Vol. 37, May 25, 1934, page 265. Metallic Ca is prepared from molten, anhydrous $CaCl_2$ (98.5-99.0 purity). It is used as deoxidation agent for cast Fe and steel, about 1 kg. is required per ton of steel. Cu also can be deoxidized by Ca without impairing the mechanical and electrical properties. Pb with less than 0.1% Ca has better mechanical properties than Pb with 1% Sb for cable sheaths. Ca removes Bi in the manufacutre of lead-white; the content of Bi in Pb can be reduced by it to less than 0.05%; the last traces of As, Sb, Ag and Cu can be removed. Ha (11a)

A Selenium Compound of High Thermo-Electric Power (Eine Selenverbindung von grosser thermoelektrischer Kraft). M. Levitskaja & V. Dlugac. *Physikalische Berichte*, Vol. 15, May 15, 1934, page 776. The combination Cu_2Se-Se is recommended as a thermo-couple which is particularly suited for radiation measurements. The following thermo-electric currents have been secured:

t°C.	70	182	298	350	395	460	515	605	655
e.m.f. in milli-volts	17	30	44	55	66	95	120	175	225

EF (11a)

Bronze Bearing Alloys, Their Properties and Applications. C. H. Leis. *Product Engineering*, Vol. 5, June 1934, pages 202-206. The requirements of various types of bearings with respect to mechanical and physical properties of the material, as plasticity, ability to resist wear, friction coefficient, compressive strength, resistance to pounding and toughness are discussed and the types of bronze metals made by the Johnson Bronze Co., to meet most different conditions are described and curves for application given. Ha (11a)

Diffusion of Hydrogen through Palladium; Influence of Pressure, Temperature, and Purity of the Metal (Diffusion de l'hydrogène a travers le palladium. Influence de la pression, de la temperature et de l' état de pureté du métal). Victor Lombard & Charles Eichner. *Comptes Rendus*, Vol. 196, June 26, 1933, pages 1998-1999. The authors have determined the diffusion of H through 4 sheets of commercial Pd brought into a state of "normal diffusion" by prolonged heating at about 500° C. in a current of unpurified electrolytic H. The influence of pressure was studied by allowing H to diffuse through Pd (1) from a chamber in which the gas was under a pressure P into a chamber free from gas and (2) from a chamber containing H under a pressure p, which was less than pressure P. The results of the tests under both the above experimental conditions have been expressed by means of equations relating diffusion to pressure and temperature. Comparison of the various equations shows that the permeability of Pd to H is considerably affected by the purity of the metal. OWE (11a)

Cold Working, Drawing and Annealing Brasses (Sur l'écrouissage, le revenu et le recuit des laitons). W. Broniewski & T. Pelczynski. *Revue de Métallurgie*, Vol. 31, Jan. 1934, pages 48-54; Feb. 1934, pages 90-96. Experiments were conducted with commercial brasses made with electrolytic Cu. The effects of cold working 33% Zn brass can be divided into three zones. Up to 30% of cold work elongation and impact value drop rapidly. Between 30% and 70% the rate slows down. From 70% upwards cold working rapidly increases tensile strength and lowers the reduction of area. With higher cold working than 30% elongation is due entirely to necking in fracturing. The fact was recorded by many investigators but never explained. In 40% Zn brasses the same three zones are observed, but the first is limited by 35% of cold work and the last starts at 75%. Drawing and annealing cold worked brasses at the same temperatures but for different lengths of time showed that the properties of brasses deformed within the second and the third zones pass during the drawing cycle through a maximum, a phenomenon not observed on brasses which were cold deformed less than 30%. A 30 minute anneal at different temperatures produces a rapid drop of hardness at the beginning after which the hardness curve flattens which corresponds, probably, to the agglomeration of the submicroscopic crystals. Until the annealing temperatures are reached, 700° C for 33% Zn brass and 600° C for 40% Zn brass, the physical properties of these metals depend not only on temperatures and time of heating but on the previous cold deformation. JDG (11a)

Mechanical Properties of Brass (Mechanische Eigenschaften des Messings). Fr. Ostermann. *Zeitschrift für Metallkunde*, Vol. 26, Feb. 1934, pages 40-44. The following German standard brasses were studied: Ms 58, Ms 60, Ms 63, Ms 67, Ms 72, Ms 80, Ms 85, Ms 90. Data on mechanical properties are given in 22 graphs; these show, for the compositions noted, the following: Brinell hardness against Cu contents from 100-40% of cast alloys rapidly and slowly cooled and also the tensile strength, elongation and notch impact value; similar values including yield point for cold-worked and annealed alloys; the variation in tensile strength, yield point, Brinell hardness, and elongation, with % cold drawing up to 20% (Ms 58); the dependence of the same propreties upon the Pb-content up to 3.5% Pb (Ms 58); the dependence of the same properties upon annealing up to 800° after cold-drawing 15%; similar data for cold-rolling of various degrees (Ms 58, 63); the effect of degree of cold drawing and of die angle upon the tensile strength and elongation (Ms 63); the tensile strength, elongation, and Brinell hardness of quenched alloys drawn to temperatures up to 600° (Ms 60); the tensile strength of tubes in dependence upon degree of cold-drawing (Ms 63); the tensile strength in dependence upon annealing temperature and time (Ms 63); the decrease in hardness after a half-hour anneal at temperatures up to 350° (Ms 67); the dependence of tensile strength upon annealing temperature for hard-drawn condenser tubes; the dependence of Brinell hardness upon grain size (Ms 67); the dependence of tensile strength, yield point, Brinell hardness, and elongation upon cold rolling up to 80% for Tombak Ms 85; similar data for Tombak Ms 90; the dependence of tensile strength, yield point, and elongation of a 70% cold-rolled Tombak alloy upon annealing up to 800°. RFM (11a)

The Elastic Properties of the Series of Solid Solutions Au-Cu, and Au-Pd and of the Alloys Cu_3Pt, Cu_3Pd and CuPd (Die elastischen Eigenschaften der Mischkristallreihen Au-Cu und Au-Pd und der Legierungen Cu_3Pt, Cu_3Pd und CuPd). H. Roehl. *Annalen der Physik*, Series 5, Vol. 18, Sept. 1933, pages 155-168. Au-Cu and Au-Pd form a continuous series of solid solutions; the relations between modulus of elasticity, of torsion, and electric conductivity to the structure were investigated. The respective curves are irregular, the original should be referred to. Ha (11a)

Modulus of Elasticity of Annealed α-bronzes (Sur le module d'élasticité des bronzes α à l'état recuit). Léon Guillet. *Comptes Rendus*, Vol. 197, Nov. 27, 1933, pages 1320-1321. Guillet discusses the difficulties encountered in obtaining accurate values for E and describes the methods employed by him in determining the Young's modulus of a series of bronzes. He shows that a linear relationship exists between E and tin content, E diminishing as tin rises from about 17,900,000 lbs./in.^{2} (1.92% Sn) to about 16,000,000 lbs./in.^{2} (9.90% Sn). This result agrees with those obtained for the torsion modulus of other solid solutions (brass, cupronickel, etc.). OWE (11a)

Absorption of Hydrogen by Palladium Black under High Pressure. V. Ipatieff & W. G. Tronow. *Journal of Physical Chemistry*, Vol. 38, Mar. 1934, pages 623-633. The solubility of H_2 in Pd was determined at 15°, 25°, 100°, 150°, 200°, and 300° C. at pressures of from 1-27 atm. In agreement with data of Hoitsema, isotherms obtained are characterized by the presence of peculiar parallel parts, distinguishing H_2 adsorption on Pd from other adsorption isotherms. With increasing temperatures these parallel parts displace themselves in the direction of high pressures and begin to incline from the vertical. At 300°C. this tends to disappear and the whole curve becomes straightened out. 10 references. EF (11a)

Nonferrous Physical Metallurgy. Review of Literature Shows Wide Variety of Work. E. M. Wise. *Mining & Metallurgy*, Vol. 14, Jan. 1933, pages 34-42. Includes a bibliography. Review of the progress made in non-ferrous metallurgy during 1932. The topics discussed are: Cu and Cu alloys by H. W. Gillett; Wrought brass and bronze by J. L. Christie; Ni by N. B. Pilling; Precious metals by E. M. Wise; Zn by W. M. Peirce; Secondary metals by William Romanoff and F. A. Wright; Pb and Sn by George O. Hiers; Nonferrous foundry practice by J. W. Bolton and S. A. Weigand; By product metals by Albert J. Phillips; New methods and tools by Samuel L. Hoyt; Al by E. H. Dix, Jr.; and Theoretical metallurgy by Robert F. Mehl. VSP (11a)

Studies of Heusler Alloys (Untersuchungen an Heusslerchen Legierungen.) S. Valentiner & G. Becker. *Zeitschrift für Physik*, Vol. 83, June 20, 1933, pages 371-403. Magnetic properties of Heusler alloys are due to the presence of the crystal Al-Mn-Cu_2 with Mn in such distribution and lattice arrangements that its magnetic properties can be fully developed; the alloy with 25% Mn, 25% Al and 50% Cu has particularly high magnetic susceptibility. It has a body-centered lattice a = 5.950 A.U. both after quenching from 850° C. and higher temperatures and after aging at temperatures below 350° C. The Curie temperatures of all alloys are in the neighborhood of 330° C. When an alloy is quenched from a temperature range between 350°—700° C. $AlCu_3$ occurs besides Mn Al Cu_2; the magnetic properties of this material are inferior to those quenched from higher temperatures. An excess of Mn can enter the lattice Mn-Al-Cu_2 without changing magnetic properties appreciably, but an excess of Al disturbs formation of crystals Mn-Al-Cu_2 and forms easily, with the Cu of these crystals, the crystal Al-Cu_3. If the Al content of the alloy exceeds, even slightly, 25% the lattice parameter changes and the magnetic properties are weak; the coercive force, however, is very strong, e.g. 900 oersteds for 25% Mn, 30% Al and 45% Cu. Ha (11a)

Diffusion in Metals (Ueber Diffusion in Metallen). W. Seith, E. Hofer & H. Etzold. *Zeitschrift für Elektrochemie*, Vol. 40, June 1934, pages 322-326. The diffusion velocities of Mg, Cd, Ni and Hg in Pb and of Pb and Hg in Cd were determined. Diffusion goes on the slower the more similar the metal diffusing into Pb is to the latter with respect to the electron arrangement in the outer shell. The mobility of the investigated metals in Pb decreases gradually in the order Au, Ag, Mg, Cd, Hg, Bi, Th, Sn. Curves showing actual values are given. Ha (11a)

Chromium-Nickel as a Corrosion Resistant Alloy. Robert J. McKay. *Metals & Alloys*, Vol. 4, Nov. 1933, pages 177-180; Dec. 1933, pages 202-204. While not a new alloy the adoption of an alloy of 12-14% Cr, 5-6% Fe, balance Ni to use in certain cooling and food handling equipment is new. Properties and applications of the alloy are given. WLC (11a)

Internal stresses and season cracking in brasses. (Tensioni interne e crepe di stagionatura negli ottoni). L. Matteoli. *La Metallurgia Italiana*, Vol. 26, Apr. 1934, pages 229-242. A summary, including an outline of the method of using a solution of $HgNO_3$ for detecting these defects. Proper methods of annealing to avoid the defects are described. AWC (11a)

Ferrous (11b)

E. S. DAVENPORT, SECTION EDITOR

Some Factors Affecting the Physical Properties and Corrosion Resistance of 18-8 Chromium-Nickel Steel Wire. W. H. Wills & J. K. Findley. *Transactions American Society for Metals*, Vol. 22, Jan. 1934, pages 1-18. Investigation of 4 heats of 18-8, C content 0.15-0.20%, 2 without Ti addition and 2 with Ti 0.66 and 0.98%. Tests were made on hot-rolled rod of ¾ and 1 in. and wire of 0.025 in. dia. Heating at 1500° F., even for long time, is without benefit upon the physical properties though some improvement is noted in corrosion resistance after holding at the decomposition temperature of 1200° F. Extra cost is not warranted by improvement and tenacious scale, causing pickling difficulties, is formed. Ti addition improves resistance to attack in the as rolled condition and after heating to 1200° F. Holding the Ti material up to 90 hr. at 1500° F. has very little effect upon physicals or corrosion resistance and there is no tendency for carbide agglomeration, indicating the stability of Ti carbide. Ti 18-8 wire, drawn with process anneals at 1720° F., showed satisfactory physicals and corrosion resistance although the physicals were slightly lower than straight 18-8 process annealed at 1820° F. Ti is much more efficient as a stabilizing agent for 18-8 than a 1500° F. treatment. Disadvantage of Ti addition is low recovery of Ti and difficulty of uniform distribution through metal. WLC (11b)

Chromium Steel Rails Are Harder, Tougher, Stronger. George B. Waterhouse. *Metal Progress*, Vol. 25, April 1934, pages 32-35. Describes the development of rails from steel containing C 0.25-0.32%, Mn 0.50-75%, P 0.04% max., Si 0.25-0.40%, and Cr 2.80-3.20%. Uniform hardness of 364-387 Brinell in the rail head compares with 235-245 for conventional C steel and 260-280 obtained with Mn 1.30-1.60%. Tensile Strength of 18,000 lbs./in.,^{2} yield point of 110,000 lbs./in.,^{2} 14% elongation and 32% reduction are shown by this Cr steel which in three years tests in track shows substantial improvement over medium Mn rail steel. The properties are obtained, as in other rail steels, by hot bed cooling. WLC (11b)

Better Steel Castings Reflected in Specifications. David Zuege. *Metal Progress*, Vol. 25, Feb. 1934, pages 22-26. Chaotic conditions in specifications for steel castings are being improved by work of A.S.T.M. Three classes of alloy steel castings are recognized in these specifications: (1) those requiring a furnace cool anneal as treatment, Class A; (2) those susceptible to the more rapid cooling of normalizing, Class B; (3) those which may be quenched in a liquid medium and drawn at 400° F. or above, Class C. The several classes are divided into grades according to physical properties attained by proper selection of composition. These specifications fix no composition limits except 0.05% max. P and 0.06% max. S. Graph shows the drawing temperatures for the three grades of Class C with 0.37% C, 1.44% Mn, 0.43% Si, and 0.13% V. Hardness, impact and other tests are discussed. WLC (11b)

Pure Carbonyl Iron as a Magnetic Material of High Permeability (Reines Carbonyleisen als hochpermeabler magnestischer Werkstoff). O. Buddenberg, F. Duftschmid & L. Schlecht. Heraeus Vacuumschmelze, 10th Anniversary Volume, 1933 pages 74-80. Fe sheet of high initial permeability (μ) can be obtained by pressing Fe powder from $Fe(CO)_5$ into rods and heating these in H_2 first at 800°-1000° C. to remove O and C, than at a higher temperature to obtain a dense sintered bar which can be forged and rolled. Sheet thus prepared, and subsequently annealed in vacuum at 850-890° C. and slowly cooled, has μ over 2000, with a coercivity of 0.08 Oersted and a remanence of 6000-8000 gausses; the magnetic properties show no tendency to alter after prolonged aging at 20° or 100° C. (11b)

On the Chilling Ability of Cast Iron (Sur le Pouvoir Trempant des Fontes). A. Portevin. *Revue de la Soudure Autogène*, Vol. 25, Nov. 1923, pages 2902-2903. Chilling ability is measured by the cooling rate at which a white Fe structure begins to be obtained with a given type of cast Fe. Cooling rate can easily be varied by changing thickness of castings or test bars. Use of chill test in which a bar is cast against a metal chill gives information on chilling ability. Factors affecting chilling ability are reviewed: (1) thermal history; (2) original temperature and cooling rate; (3) inclusions and chemical conditions of melting and deoxidation; (4) original structure and, more particularly, fineness of structure; (5) particular effect of "chilling" elements. FR (11b)

Heat-Resisting Steels of the Present Day. Frederick M. Becket. *Iron Age,* Vol. 132, Aug. 3, 1933, pages 29, 66. Abstract of paper read before the New York chapters of the national mechanical, metallurgical, welding and electrochemical engineering societies. Outline of the present array of heat-resisting steels and their various uses. Discussion is limited to heat-resisting steels containing at least 50% Fe. VSP (11b)

The Potentialities of Cast Iron. A. B. Everest. *Foundry Trade Journal,* Vol. 50, Mar. 29, 1934, pages 219-220; Apr. 5, 1934, pages 227-228. Recent developments in cast Fe practice are discussed; strengths of 56,000 to over 67,500 lbs./in.^{2} being readily obtained in commercial castings. Reference is made to the use of cast iron crank shafts, the author believing the value of cast Fe in this connection to be due to its high endurance limit. Alloy, chilled Fe castings are also discussed, as are low-expansion cast Fe's such as those used in pistons, etc. OWE (11b)

The Addition of Non-Ferrous Metals to Cast Iron. J. E. Hurst. *Foundry Trade Journal,* Vol. 50, Jan. 11, 1934, pages 21-22, 28; Jan. 25, 1934, pages 73-75. Covers the addition of non-ferrous metals to cast Fe as practiced commercially today. The iron foundry is now able to offer the engineer high-quality gray, high-strength gray, hard white, hard martensitic, oil- and air-hardening, nitrogen-hardening, chromium alloy, and austenitic cast Fe's. OWE (11b)

Strength and Solidity of Cast Iron (Quelques Principes dont Dépendent la Résistance et la "Solidity" dans la Fonte). W. West. *Bulletin de l' Association Technique de Fonderie,* Vol. 7, Dec. 1933, pages 514-527. British exchange paper presented at Foundry Congress, Paris, 1933. Low C cast Fe produced by the addition of steel to the mixture gives castings having great strength and soundness. The shorter freezing range of this Fe is due to lower C and P contents. The P and Si contents of cast Fe must be balanced. Effect of P on physical properties of cast Fe of different C contents is considered. WHS (11b)

Reader Comments on High Temperature Impact Resistance of Cast Iron. C. M. Loeb, Jr. *Metals & Alloys,* Vol. 5, Mar. 1934, page 60. It is pointed out in connection with "Impact Resistance of Cast Iron at Elevated Temperatures" F. B. Dahle, *Metals & Alloys,* Vol. 5, Jan. 1934, pages 17-18 that Mo cast Fe's have higher hardness at elevated temperatures and that in spite of this the impact resistance is superior in these Mo Fe's. The spread in hardness between the Mo and plain Fe probably increases with temperature so that the toughening effect of the Mo is off-set at these higher temperatures by the greater hardness. WLC (11b)

Pure Iron. N. A. Ziegler. *Metal Progress,* Vol. 5, Oct. 1933, pages 26-29 and 68. Discussion of the effects of impurities on magnetic properties and space lattice of vacuum melted and annealed electrolytic iron. C, O_2, S and Mn increase hysteresis loss and decrease maximum permeability. Effect of P is small. Effects of special purification on the A_3 and A_4 points indicate that absolutely pure iron, if prepared, would have no gamma state. WLC (11b)

Electric Furnace Iron Highly Resistant to Abrasion. *Iron Age,* Vol. 133, Apr. 5, 1934, pages 33-34. Describes an electric furnace white Fe alloy known as Riloy No. 31 containing both Ni and Cr and used for pulverizer equipment parts. It has a Brinell hardness of 600+. It was developed by Riley Stoker Co. VSP (11b)

Heat and Acid Resisting Alloys. J. Ferdinand Kayser. *Foundry Trade Journal,* Vol. 50, Jan. 11, 1934, pages 26-28. With discussion. Gives the history of these alloys, particularly in the form of castings and discusses the present patent situation. Inquires into what constitutes improvement in these alloys and deals with the matter of development work needed. OWE (11b)

Survey of Modern Engineering Materials and Machinability. A. Craig MacDonald. *Edgar Allen News,* Vol. 12, Apr. 1934, pages 416-418; May 1934, pages 440-441; *Journal of the Institution of Production Engineers,* Vol. 13, Feb. 1934, pages 57-79. Includes discussion. Brief survey of the properties of alloy steels and cast irons. Brinell hardness is not always a guide to machinability. Excessive work hardening by blunt tools may give trouble with stainless steels. Very soft materials may tear. Heat treatment to secure best condition for machining is often advisable. JCC + Ha (11b)

The Influence of Beryllium on Steel. J. H. S. Dickenson & W. H. Hatfield. *Foundry Trade Journal,* Vol. 49, Oct. 19, 1933, pages 221-222; Oct. 26, 1933, pages 237-238. Extended abstract of paper presented before the Iron & Steel Institute. See *Metals & Alloys,* Vol. 5, May 1934, page MA 225. OWE (11b)

Grain Size and Mechanical Properties of Malleable Cast Iron. F. Loepelman. *Foundry Trade Journal,* Vol. 49, Nov. 9, 1933, page 262. Extended abstract of article which appeared in *Die Giesserei.* See "The Mechanical Properties of Malleable Iron with Particular Regard to its Grain Size," *Metals & Alloys,* Vol. 5, May 1934, page MA 225. OWE (11b)

Some Experiments on the Resistance to Wear of Nitrogen-Hardened Cast Iron. J. E. Hurst. *Engineering,* Vol. 137, Jan. 12, 1934, pages 50-51. From paper read before the Iron and Steel Institute, Sheffield, Sept. 14, 1933. See *Metals & Alloys,* Vol. 5, May 1934, page MA 224. LFM (11b)

Experiments Relating to Production of Low Carbon Cast Iron with High Resistance (Expériences rélatives à la Production des Fontes à Résistance elevée, à bas Carbone). V. Palchetti. *Revue de Fonderie Moderne,* Vol. 28, Apr. 10, 1934, pages 106-110. See "Experiments on Cast Irons of High Resistance and Low Carbon Content," *Metals & Alloys,* Vol. 5, May 1934, page MA 222. Ha (11b)

Relationship between Wall-Thickness, Test-Bar Diameter and Maurer Diagram for Cast Iron. *Foundry Trade Journal,* Vol. 50, Oct. 12, 1933, page 209. Extended abstract of paper by M. von Schwarz & A. Väth, which appeared in *Die Giesserei.* See *Metals & Alloys,* Vol. 5, May 1934, page MA 222. OWE (11b)

Hardness of Chill Rolls. Scharffenberg. *Foundry Trade Journal,* Vol. 49, Dec. 7, 1933, page 330. Extended abstract of paper on the above subject, which appeared in *Die Giesserei* Aug. 18, 1933. See *Metals & Alloys,* Vol. 5, May 1934, page MA 222. OWE (11b)

Anomalies in the "Temper" of Cast Iron; Their Relation to Oxidation (Amonalies de Trempe des Fonte; leur Rapport avec l'Oxidation). A. le Thomas. *La Fonderie Belge,* Oct. 1933, page 157; *La Fonte,* Vol. 3, Oct.-Nov.-Dec. 1933, pages 359-371. See *Metals & Alloys,* Vol. 5, May 1934, page MA 221. FR (11b)

Effect of Aluminium upon Cast Iron. E. Piwowarsky & E. Söhnchen. *Foundry Trade Journal,* Vol. 49, Dec. 14, 1933, page 344. Extended abstract of an article which appeared in *Metallwirtschaft* (Vol. 12, 1933). See *Metals & Alloys,* Vol. 5, Feb. 1934, page MA 70. OWE (11b)

Wall-Thickness Sensitivity and Accuracy of Castings of Unalloyed and Alloyed Cast Iron (Wandstärkenempfindlichkeit und Treffsicherheit bei unlegiertem und legiertem Gusseisen). E. Piwowarsky & E. Söhnchen. *Mitteilungen aus dem Giesserei-Institut der Technischen Hochschule Aachen,* Vol. 3, Jan. 1934, pages 463-468. See *Metals & Alloys,* Vol. 5, Feb. 1934, page MA 61. Ha (11b)

Steels of the Air Hardening Type. E. C. Wright & P. F. Mumma. *Heat Treating & Forging,* Vol. 20, Jan. 1934, pages 19-21; Feb. 1934, pages 82-84. See "Properties of Low-carbon Medium-chromium Steels of the Air-hardening Type," *Metals & Alloys,* Vol. 4, Sept. 1933, page MA 278. MS (11b)

Metallurgists Debate Merits of Alloying Elements. T. W. Lippert. *Iron Age,* Vol. 133, May 17, 1934, pages 26-27, 62. Abstract of discussion on relative merits of Mo, Ni and V as alloying agents in steel before Washington Chapter of the American Society for Metals. H. W. Gillett discussed Mo, H. J. French Ni, Jerome Strauss V, and P. E. McKinney alloys in general. Mr. McKinney stressed the great variations in physical characteristics of alloys; these variations depend largely on the part tested and the conditions of test. The fallacy of using comparative physical tests on castings and forgings to measure the relative merits of products produced by the 2 forming operations was pointed out. Mr. Strauss summarized a large amount of experimental data in order to present the more important phases of V as an alloying element in steel. Mr. French dealt with the usefulness of Ni in structural steel for the purpose of gaining strength without proportionately great losses in ductility. Dr. Gillett stated that one specific use of Mo is to increase strength at high temperatures. Mo lowers the critical rate of cooling for hardening in low alloy CrMo or Ni steel several times as much as any one of the other elements. VSP (11b)

The Value of Young's Modulus for Steel. H. H. Abram. *Iron & Steel Institute, Advance Copy* No. 4, May 1934, 6 pages. Careful measurements of Young's modulus were made independently at the National Physical Laboratory and at Woolwich Arsenal. Extensometers of the Martens type were used. A variety of plain C and alloy steels was tested. Results are reported to the nearest 0.01 x 10^6 lbs./in.^{2} "although this is rather beyond the accuracy of the experimental readings." Ingot iron and mild steel have a definitely higher modulus than medium- and high-C steels, but the influence of C content on the modulus could not be determined exactly because of variation in Mn content of the samples. Pure iron, annealed, would have a modulus of 30.2 x 10^6 lbs./in.^{2} The addition of 0.5% C would decrease this to 29.7 x 10^6 lbs./in.^{2} In 13% Cr steels C tends to raise modulus. Si decreases modulus of low-alloy steels but increases it for 13% Cr steels. Ni tends to reduce modulus while Cr raises it. Heat treatment does not affect modulus. The modulus was the same in transverse and longitudinal samples. Values listed are correct to within ±0.25%. JLG (11b)

The Torsion Impact Properties of Hardened Carbon Tool Steel. G. V. Luerssen & O. V. Greene. *Transactions American Society for Metals,* Vol. 22, Apr. 1934, pages 311-346. Torsional impact data obtained on are reported for quenching temperatures of 1450, 1500, and 1550° F. and draws of 200, 300, 400, 500, 600, 700, and 800° F. Peaks in toughness are shown by all steels in the neighborhood of 400° F. draw differing slightly for different quenching temperatures. Effect of furnace atmosphere was studied and found to be marked in case of brittle timbre steel in which case a reducing atmosphere produced very low impact values. Lead pot treatment produced highest values for brittle timbre steels. Tough timbre steel is little affected by atmosphere. Increased time at drawing temperature does not increase toughness but moves the peak to a lower drawing temperature. WLC (11b)

	C	Mn	Si	P	S	Cr	Ni
Tough Timbre Steel	1.06%	0.20%	0.16%	0.010%	0.012%	0.03%	0.04%
Brittle Timbre Steel	1.03	0.23	0.16	0.019	0.017	0.06	0.10
Heading Die Steel	0.90	0.45	0.50	0.014	0.009	0.08	0.08

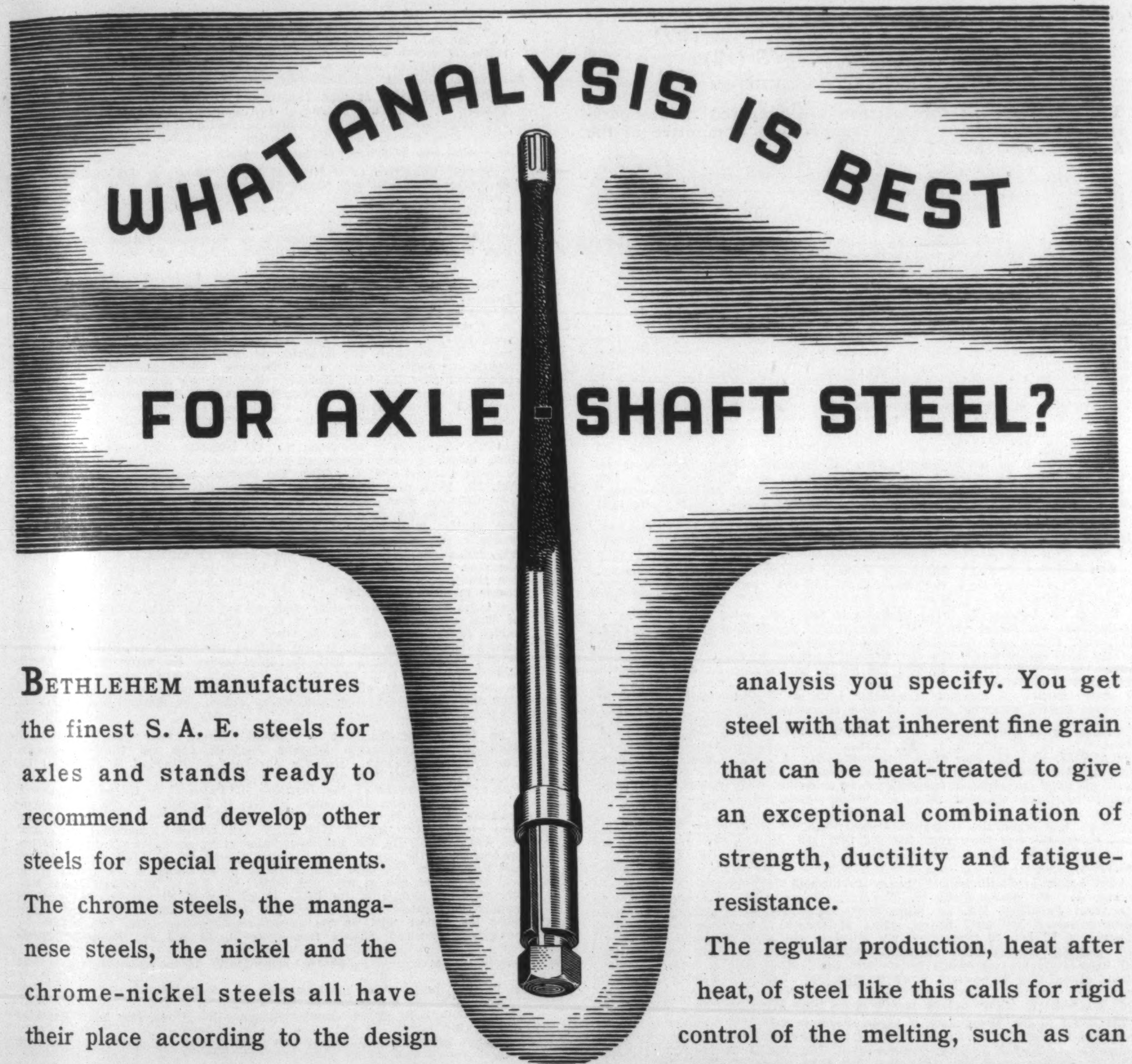
The Question of Phosphorus in Cast Iron (La Question du Phosphore dans la Forte). G. LeBruly. *Revue de Fonderie Moderne,* Vol. 28, May 10, 1934, pages 134-135. Ordinary pig irons fall into two classes: 1. phosphorous cast Fe containing a fairly high amount of P and less than 1% Si; so-called basic pig iron, used for making steel by basic processes which permit elimination of almost all the harmful P; 2. pig iron with less than 0.1% P and 1.0 to 1.5% Si; so-called acid pig iron, used for making steel by acid processes in which P can not be eliminated. During melting in the cupola no loss of P occurs while some Fe, Mn and Si is always lost, hence the P content in the product is somewhat higher than in the charge. P-bearing Fe is more fluid than other Fe as P lowers the melting point and widens the range of solidification. P lowers the eutectic C content. Tensile strength is not essentially influenced by P contents up to 0.7%; beyond this amount P is harmful. P does not affect brittleness; deflection depending on the value (C + 0.25 Si). Resiliency is reduced by P; hardness is sometimes increased by P making machining more difficult. Ha (11b)

Solubility of Hydrogen and Nitrogen in Iron-Molybdenum Alloys (Das Aufnahmevermögen der Eisen-Molybdän-Leigierungen für Wasserstoff und Stickstoff). A. Sieverts & K. Brüning. *Archiv für das Eisenhüttenwesen,* Vol. 7, May 1934, pages 641-645. Solubility of H and N in Fe-Mo alloys was determined at pressures of 100 to 760 mm. and at temperatures of 300° to 1100° C. At constant temperature the gas absorption was proportional to the square root of the pressure. The solubility varied sharply when a phase boundary of the Fe-Mo diagram was crossed. Between Mo contents of 6.1 to 83.7 atomic % large amounts of N were absorbed, presumably through formation of a N-rich phase. SE (11b)

Some Effects of Cold-rolling on the Intergranular Corrosion of the 18/8 Stainless Steels. E. C. Rollason. *Iron & Steel Institute, Advance Copy* No. 17, May 1934, 8 pages. Cold rolling lowers the temperature range in which steel of the 18Cr-8Ni type becomes sensitive to intergranular corrosion. Cold rolling of steel, made sensitive by annealing in the dangerous range, increased the rate of corrosion as measured by change in electric resistance. Structural changes that result in intergranular sensitivity are described. Intergranular corrosion near welds may be reduced or prevented by: (1) Reducing the C to 0.02%, either as manufactured or by precipitating the excess by annealing cold-worked material for a long period at 700-850° C.; (2) the addition of ferrite-producing elements such as Si or Mo; (3) production of carbides other than those rich in Cr by adding such elements as Ti, W, Mo, or Cb and annealing in the region 900-1000° C. to allow the more stable carbides to form. 6 references. JLG (11b)

The Thermal Conductivity of Tool Steels. Denzaburo Hattori. *Iron & Steel Institute, Advance Copy* No. 7, May 1934, 18 pages. Thermal conductivities of tool steels were determined in an apparatus using a water-flow calorimeter. C steels, a Cr steel, a W steel, and several high-speed steels were tested. Steels were tested as annealed, as quenched, and after quenching and tempering at different temperatures. Several temperature ranges were used in testing each specimen. Results of each test are tabulated. It was concluded that thermal conductivity varies with the structure as follows: λ austenite $< \lambda$ martensite $< \lambda$ pearlite. For quenched C steels the thermal conductivity increases with tempering temperatures. The higher the quenching temperature the lower is the conductivity. The conductivity of high-speed steel decreases greatly on quenching, and on tempering it increases a little at 300° C., greatly at 550° C. and still more at 700°-800° C. The increased durability brought about by tempering high-speed steel is attributed to the increased thermal conductivity. 21 references. See also Metals & Alloys, Vol. 5, May 1934, page MA 226. JLG (11b)

Ageing Changes in Nitrided Steel. Edward G. Herbert. *Iron & Steel Institute, Advance Copy* No. 8, May 1934, 4 pages. Periodic fluctuations were observed in the "diamond-time hardness" of nitrided steels. Hardness could be stabilized at a maximum or a minimum value by application of a constant magnetic field. Hardness fluctuations are attributed to a periodic fluctuation of the interatomic forces of attraction, which causes corresponding fluctuations in the cohesion between the slip planes and the resistance the metal offers to deformation. 4 references. JLG (11b)



WHAT ANALYSIS IS BEST FOR AXLE SHAFT STEEL?

BETHLEHEM manufactures the finest S. A. E. steels for axles and stands ready to recommend and develop other steels for special requirements. The chrome steels, the manganese steels, the nickel and the chrome-nickel steels all have their place according to the design contemplated.

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BETHLEHEM *Fine* ALLOY STEELS

EFFECT OF TEMPERATURE ON METALS & ALLOYS (12)

L. JORDAN, SECTION EDITOR

The abstracts in this section are prepared in co-operation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M.

Comparative Studies on Creep of Metals Using a Modified Rohn Test. C. R. Austin & J. R. Gier. *Iron & Coal Trades Review,* Vol. 128, Mar. 9, 1934, page 404. See *Metals & Alloys,* Vol. 5, June 1934, page MA 290. Ha (12)

Scientific and Industrial Research. *Engineer,* Vol. 157, Jan. 26, 1934, pages 90-91. Short summary of work carried out at the National Physical Laboratory on behavior of materials at high temperatures and on cracking of boiler plates. LFM (12)

Thermal Stresses in Pipe Joints for High Pressures and Temperatures. R. W. Bailey. *Engineering,* Vol. 137, Apr. 20, 1934, pages 445-447; May 4, 1934, pages 506-507. Mathematical treatment of subject dealing mainly with the question of influence of design and construction in minimizing thermal stresses. Three types of joints are considered, the usual loose flange joint, rectangular welded-on flange, and the improved loose flange joint. It was found that thermal stress was higher in the normal loose flange joint than in the welded-on flange or in the flange which is solid with the pipe wall. This stress is relieved by reversing the orientation of the flange cross-section. The region of maximum stress in the usual loose flange type of joint when heating up is in the zone of maximum temperature while in the improved type it is in the zone of lowest temperature. LFM (12)

Red-Brittleness of Copper-Steels; Means of Prevention (Fragilité au rouge des aciers au cuivre: Le moyen de l'éviter). F. Nehl. *Usine,* Vol. 43, Jan. 25, 1934, page 31. See "Hot-Shortness in Copper-Bearing Steels and Its Prevention," *Metals & Alloys,* Vol. 5, Apr. 1934, page MA 160. Ha (12)

Furnaces for Elevated Temperature Tests. H. Montgomery & J. W. Bolton. *Metals & Alloys,* Vol. 5, June 1934, pages 127-128, 130. Describes furnaces for both creep and short-time high-temperature tests. WLC (12)

Heat-Resisting Cr-Ni-Fe Alloys for Furnace Construction. L. J. Stanbery. *Metals & Alloys,* Vol. 4, Oct. 1933, pages 159-164. Part II discusses selection for specific uses. WLC (12)

Method for Determining Creep in Hardened Steel (En metod för bestämning av krympningen hos härdat stål). W. Weibull. *Jernkontorets Annaler,* Vol. 117, Oct. 1933, pages 512-516. The change in length of a sample is measured by the variation in capacity of an air gap condenser of which the sample is a part. The electrical circuit involves the use of an amplifier for determining the change in capacity. Absolute values are determined by comparing with samples of known length. A constant temperature bath at 20 ± 0.1° C. is required to eliminate thermal expansion during any given measurement. HCD (12)

Comparison of Single-Step Long-Time Creep Results with Hatfield's Time-Yield Stress. A. E. White & C. L. Clark. *Transactions American Society for Metals,* Vol. 22, June 1934, pages 481-504. A study of one of the short-time methods advocated by certain metallurgists for determining creep characteristics of metal at elevated temperatures to determine if it yields results comparable to those obtained from a carefully conducted long-time creep test. Results are given for three steels at 850° F. and eleven at 1000° F. It is concluded that while the time-yield method does not yield results which are in exact agreement with those from the long-time test, it does offer possibilities as a qualitative test for classifying a series of steels of a given type at any given temperatures. WLC (12)

Load Losses in Small Helical Springs at Elevated Temperatures. F. P. Zimmerli, W. P. Wood & G. D. Wilson. *Transactions American Society for Steel Treating,* Vol. 21, Sept. 1933, pages 796-806. Data taken on load losses sustained by small helical spring at elevated temperature are reported. Exposure of 72 hrs. to temperature was found to give most reliable results. For each material there appears to be a limiting temperature below which stress and temperature are controlling factors and above which time is important. For ferrous alloys this temperature varies between 200°-700° F., stainless and high speed steel showing highest temperatures. Monel shows good resistance up to 400° F., while Cu alloys fall off rapidly above 100° F. WLC (12)

The Effect of the Temperature of Liquid Hydrogen (-252.8° C.) on the Tensile Properties of Metals. W. J. DeHaas & Robert Hadfield. *Philosophical Transactions Royal Society, London,* Vol. 232 (Series A) Dec. 1933, pages 292-332; *Engineering,* Vol. 137, Mar. 16, 1934, pages 331-333. Reviews the previous work of Hadfield and Dewar and of Hadfield and Onnes on the properties of iron and steels at temperatures of liquid air and of liquid He. The objects of the present research were to follow to even lower temperatures the changes already observed in the tensile properties of iron and its alloys at -182° C.; also, to observe whether these changes follow a regular progression, or whether any critical change of behavior occurs. The specimens, which had an over-all length of 47 mm. and a diameter over the parallel portion of 3 mm., were allowed to attain the temperature of the liquid hydrogen before applying the stress and remained immersed the whole time until fracture occurred. The forty-one materials tested were divided into groups, as follows: Group I, Swedish charcoal iron; Group II iron alloyed with one main element; Group III, iron alloyed with two main elements; Group IV-a, iron alloyed with three main elements; Group IV-b, iron alloyed with chromium, nickel, silicon, and tungsten; and Group V, non-ferrous metals and alloys. The severity of the effect produced by liquid hydrogen is shown by the fact that only six of the twenty-nine ferrous materials retained any appreciable ductility. Among the remaining twenty-three which became brittle were the eleven materials that had previously shown little or no elongation in liquid air. In this group is the metal iron itself, which showed no return of its toughness on taking the temperature below -182°. The remaining twelve materials possessed in liquid air a ductility of from 5 to 17%. The plain high-percentage nickel steels suffered no appreciable reduction by the further drop in temperature. Nickel and copper, showed by exposure to liquid air, an improvement in their ductility, already high at ordinary temperature. With copper, the ductility still further increased from 45% to 60% in liquid hydrogen. Previous experience had indicated that specimens containing 0.71% chromium and 3.34% nickel retained in liquid air much of their original ductility, and to an extent rather better than similar nickel steels without chromium. The results in this experiment showed that under very severe cooling in liquid hydrogen the ductility of this steel was adversely affected. While, in accordance with observations at liquid air and other subnormal temperatures, the general effect is an increase in tenacity, at the temperature of liquid hydrogen there are important changes. The number of exceptions—that is, materials whose tenacity is actually diminished or shows no increase, amounts to seven out of forty-four. In liquid air, there were only five out of 129 tests, these too comprising a much greater range of materials. Out of twenty-nine ferrous materials which have been tested both in liquid air and liquid hydrogen, the ratio of increase in tenacity is less at the lower temperature of liquid hydrogen in thirteen materials, and practically the same in 10 others. Only in the remaining six is the ratio increased. C. E. MacQuigg + LFM (12)

Cast Iron Versus Heat. E. W. Harding. *Iron & Steel of Canada,* Vol. 17, Mar.-Apr., 1934, pages 19-22. An illustrated article dealing with the causes of growth of cast iron and condition requisite in cast iron to resist growth. Refers in closing to alloys marketed by the Robert Mitchel Company, Montreal, which are characterized by heat-resisting qualities. OWE (12)

Strength of Steels at High Temperatures (Qualités de Résistance des Aciers à Chaud). F. Körber. *Chaleur et Industrie,* Vol. 15, Mar. 1933, pages 239-246. Paper read at the 3d Congress of Industrial Heating—Paris, Oct. 10-14, 1933. Creep limit is discussed at length. Descriptions of testing apparatus and of a short test method are given. FR (12)

Strength Characteristics of Metal at High Temperatures (Les Caractéristiques de Résistance des Metaux aux Hautes Temperatures). M. Ros & A. Eichinger. *Chaleur et Industrie,* Vol. 15, Mar. 1933, pages 211-222. Paper read at the 3rd Congress of Industrial Heating, Paris, Oct. 1933. The authors discuss phenomena of slip within crystals of metals stressed under static loads and the effects of time and low and high temperatures on elongation. Fatigue and the Bauschinger effect are also discussed. Description of Amsler and Shenk testing machines. FR (12)

Methods For Corrosion Study of Metals and Alloys in Gases at Elevated Temperatures and Their Applications (Méthodes d'études de la corrosion des métaux et alliages par les gaz à témperature elevée et leurs applications). A. Portevin, E. Pretet & H. Jolivet. *Revue de Métallurgie,* Vol. 31, Mar. 1934, pages 101-115; Apr. 1934, pages 186-191; May 1934, pages 219-236. 49 references. A new method and apparatus are described. Specimens are heated in an electric wire wound furnace in a gas atmosphere. The volume of the gas is measured before and after the test. Remelted electrolytic Fe oxidized at 800°-1000° C. according to the parabolic law: $W^2 = Kt$ where W is the volume of gas absorbed, K coefficient and temperature. At the beginning, oxidation does not always follow this law, but after some time, the parabolic relation is evident. Initial oxidation might be responsible for this. Plotting log K as a function of the inverse absolute temperature it was found that the values are distributed along a straight line, though a break corresponding to the change of the angular coefficient is observed around 900° C. Pilling and Bedworth, *Journal Institute of Metals,* Vol. 29, 1923, pages 529-591, do not report this break though their results on electrolytic Fe check closely the data obtained. Oxidation of Fe-Al alloys follows the same law up to 5% Al. Variations of K are practically a straight line function in this range. Above 5% Al scattered results were observed and parabolic law did not hold. Fe-Cr with 6% Cr max. behaves in the same way, but at higher temperatures a much higher Cr content is required to produce the same immunity. About 5% Si interferes with the functioning of parabolic law and the metal oxidizes slowly at first but more rapidly later. Only a slight change in the rate of oxidation at the α-γ transformation point was observed on the latter alloys. Metallographic study of the oxide layers supported the results of Pfeil and others. In the binary alloys oxidation varies with the character of oxides formed. At the beginning they have the characteristics of iron oxides passing later through more or less complex mixtures to practically pure oxides of the addition element. With the same amount (in weight %) of addition element the temperature resistance of the alloys increases inversely proportionally to the atomic weight of the addition. Oxidation curves of a 2% Fe-Be alloy show that Be exerts a strong anti-scaling action. 58 diagrams and illustrations. JDG (12)

On the Magneto-Resistance of Bismuth, Nickel, Iron, Cobalt and Heusler Alloy by the Longitudinal Magnetic Field at Low and High Temperatures. Yosiharu Matuyama. *Bulletin Institute of Physical & Chemical Research, Tokyo,* Vol. 13, Apr. 1934, pages 283-313. In Japanese. *Scientific Papers & Abstracts of the Institute of Physical & Chemical Research, Tokyo,* Vol. 24, Apr. 1934, pages 22-23. In English. The changes in electric resistance of Bi, Ni, Fe, Co and of a Heusler alloy were studied in longitudinal electric fields up to 1700 gauss and between temperatures of —196° and 830° C. In Bi, the magneto-resistance increases at high temperatures proportionally to the square of the magnetic field up to 1700 gauss. At very low temperatures the same ratio increases proportionally to the square of the field only in the case of very weak fields. The rate of its increase drops gradually with the increase of the field. In its case of Ni and Fe, the results of previous investigators were confirmed. A sharp minimum is also found slightly below the critical point on the magneto-resistance-temperature curve. With Co, curves were obtained differing from those on Ni and Fe. Below 0° C. the magneto-resistance $\frac{\Delta R}{R}$ increases proportionally to the magnetic field at least up to 1600 gauss. When the temperature is raised, the rate of increase of the curve $\frac{\Delta R}{R}$ —H (R = electric resistance, H = magnetic field) diminishes gradually. Saturation in a field of 500 gauss at 261° C. was found. The curve $\frac{\Delta R}{R}$ —T (T = temperature) has a maximum around 210° C. when the magnetization increases steeply. In the case of the Heusler alloy, the sign of the magneto-resistance is negative for all temperature ranges. At low temperatures its absolute value is very large. The resistance-temperature curve was determined on all the metals mentioned. In the ferro-magnetic materials its rate of increase is relatively small at first and increases gradually with rising temperatures up to the critical point where the rate drops abruptly and then remains constant. WH (12)

Bolts and Nuts at High Temperatures. Allan C. MacNeish. *Metallurgist* (Supplement to *The Engineer),* Feb. 24, 1933, pages 13-14. The unusual stresses to which bolts and nuts may be subjected in a boiler plant and the conditions of service of high temperature steam piping require a bolt and nut steel that will not seize or "weld" and one that will retain its high qualities indefinitely. VVK (12)

Scaling of Steel at Heat-treating Temperatures. C. Upthegrove. *Engineering Research Bulletin* No. 25, *University of Michigan,* Aug. 1933. Paper, 6 x 9 inches, 38 pages. Price 50 cents. Presents results of an investigation sponsored at the University of Michigan by the Industrial Gas Research Committee of the American Gas Association. First part of the work consisted of investigating individual factors which affect the scaling: temperature, time of exposure to scaling medium, rate of flow of scaling agent, partial pressure of scaling agent, and nature of the scaling agent itself. Scaling determinations were made for dry air, O, CO_2 and water vapor, over the range 1000° to 2000° F. In second phase of investigation, results of these fundamental studies were carried over to the complex types of combustion atmospheres, obtained by burning manufactured gas with different gas-air ratios. The scaling of any steel is shown to be related to temperature, nature of scaling agent, time of exposure, dilution of scaling agent by N, and its velocity, hence (in a city gas-air combustion atmosphere) to the character of the furnace atmosphere; and may be reduced by adjusting gas-air ratio. See also *Metals & Alloys,* Vol. 5, Jan. 1934, page Ma 5. MFB (12)

Computation of Stresses in Pipe Lines at High Pressures and High Temperatures (Calcul des Tensions dans les Tuyauteries Soumises aux Hautes Pressions et aux Hautes Températures). Alfred Van Wassenhove. *Chaleur et Industrie,* Vol. 14, Mar. 1933, pages 113-119. Theoretical study of the stresses due to temperature gradients in the walls of water and steam tubes operating at high pressures and temperatures. Tube failures are also dealt with. FR (12)

CORROSION & WEAR (13)

V. V. KENDALL, SECTION EDITOR

Corrosion and Protection of Condenser Tubes (La corrosion et la protection des tubes de condensers). M. Varinois. *Le Caoutchouc et la Gutta-Percha,* Vol. 30, Jan. 15, 1934, pages 16272-16274, Apr 15, 1934, pages 16374-16375. The problem of condenser tube corrosion is rather complicated since 3 factors come into play: chemical, electrolytic reactions, and physical or metallurgical conditions. These factors even vary within the same tube. Damages arising at the inside may be due to unsuitable structure or composition and defects starting from the outside may be due to mechanical injuries, detrimental ingredients in the water, too high a water temperature, eddy currents or excessive vibration. Electrolytic coatings on the tube do not furnish sufficient protection. Sn coatings at the inside yielded good results in some cases. Pb coats proved to be a success, unless the flow rate of the water was exceedingly high. Paint coatings interfere with the heat transfer. A coat of boiled linseed oil on Sn-plated tubes furnishes adequate protection for one year at low flow rates of the water. Occasional cleaning of the tube tends to improve the heat transfer and should not be carried to excess due to the danger from corrosion. WH (13)

Some Factors Involved in Soil Corrosion. E. R. Shepard. *Industrial & Engineering Chemistry,* Vol. 26, July 1934, pages 723-732. Laboratory experiments on the causes and mechanism of soil corrosion of ferrous materials are described. An unbroken mill scale has a protective influence, while a discontinuous mill scale may facilitate pitting. The presence and distribution of O in a soil is an important factor in soil corrosion. Unequal distribution of O occurs in dry or porous soils where a nonuniform condition of the soil aggregate exists. Such conditions give rise to local galvanic action on buried Fe pipes. In most soils the maximum rate of corrosion occurs when the soil is moist rather than wet or saturated. This is because of the limited supply of O in saturated soils. The electrical resistivity of soil is an important factor in corrosion but other less definite properties are often the controlling ones. MEH (13)

Report of A. P. I. Research Associate to the Committee on Corrosion of Pipe Lines. Gordon N. Scott. *Proceedings American Petroleum Institute,* Vol. 14 (IV), 1933, pages 204-220. *Part 1—Adjustment of Soil-Corrosion Pit-Depth Measurements for Size of Sample.* See also *Oil & Gas Journal,* Vol. 32, Nov. 2, 1933, page 69. About 8800 pit-depth measurements on small isolated specimens and 7 actual operating pipe lines have been studied with reference to their significance as a measure of soil corrosion. The quantitative relation between means of the maximum pit depths and area has been shown for the data presented to be nearly linear on logarthmic coordinates for a considerable range in area. As a result of this study it is suggested: (a) that pit depth be taken consecutively on each running foot of pipe, within the extent of the inspection hole, and that preferably 8 or more, but certainly not less than 4, such measurements be taken per hole and (b) that all pit-depth measurements on pipe lines be corrected to a standard area of 45.16 sq. ft. corresponding to a 20-ft. length of 8-in. pipe when comparison with data from different sources is intended. Formulas are given to permit this correction. *Part II—A Preliminary Study of the Rate of Pitting of Iron Pipe in Soils.* The slowing-up of the pitting rate of iron pipe in soils is probably due to many factors, among which: (1) the protective effect of the corrosion products which accumulate near the pipe, and (2) the enlargement with time of the anodic or corroding areas, are important. The amount of rust formed, and its distribution and thickness, are determined partly by the acidity of the soil, and partly by the rate at which oxygen can reach the dissolved iron—which, in turn, is affected by the amount of moisture in the soil. The following equation represents the available data on pit depths for both pipe lines and test specimens with sufficient accuracy to warrant its further investigation. $P = \frac{UT}{B + T}$ where P is the measure of corrosion (pitting) which has occurred; T is the time; and U and B are constants. Since the values of B range roughly between 2.5 and 7.5 and since it is impossible with present data to determine in advance its precise value, the value of $B=5$ has been adopted tentatively. This then makes it possible to approximate a value for U from a single pair of associated values of average pitting and time and the equation becomes of practical value. VVK (13)

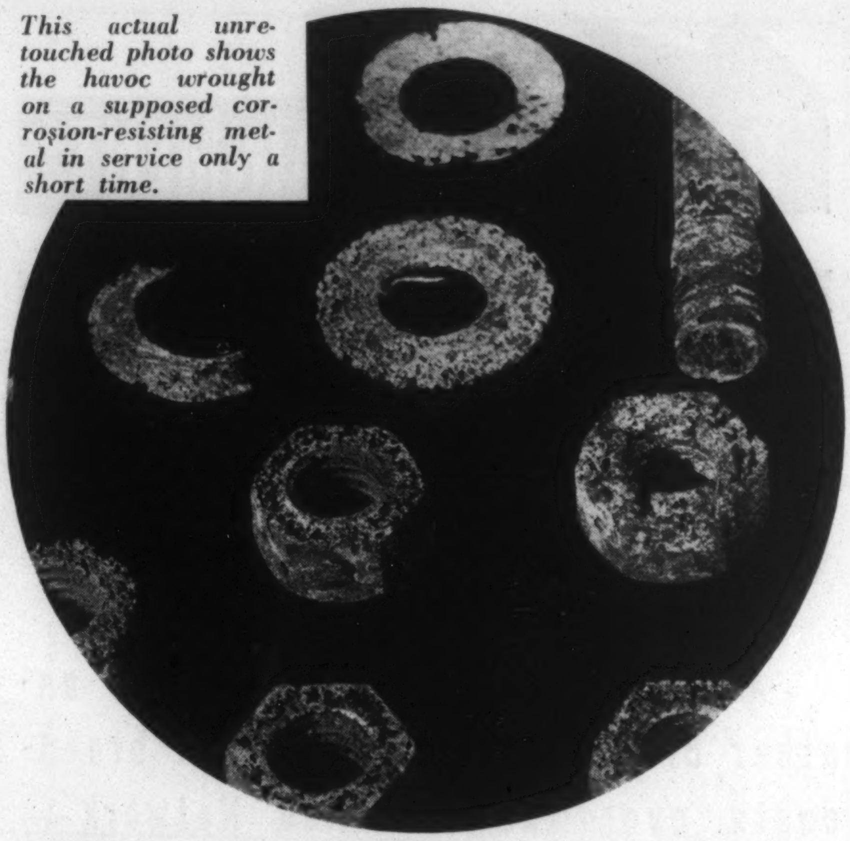
Chemical Resistance of Stainless Steels (Die chemische Widerstandsfähigkeit nichtrostender Stähle). Paul Schafmeister. *Technische Mitteilungen Krupp,* No. 1, Feb. 1934, pages 20-27. See *Metals & Alloys,* Vol. 5, June 1934, page MA 294. Ha (13)

Protective Coatings for Penstocks. J. S. McNair. *Electrical West,* Vol. 72, June 1934, pages 104-112. A report of the Production and Generation Committee, Engineering and Operation Section, Northwest Electric Light and Power Association. After a brief discussion of corrosion and its prevention and of protective coatings, presents some of the experiences and the results obtained in cleaning and coating the interiors of penstocks on the system of the Washington Water Power Co. and describes the procedure on the Chelan penstock. Includes costs. Considers sand-blasting as the most satisfactory method of cleaning and preparing the surface, and bituminous coatings as superior to other types of coatings for steel. MS (13)

Protection of Lead in Contact with Structural Woods (La protection du plomb en contact avec les bois de construction). J. Mahul. *Genie Civil,* Vol. 104, Mar. 1934, pages 274-275. In contact with dry wood Pb does not need any protection. When the wood is wet, its Pb corrosive properties depend on the presence of acids either originally present or produced by hydrolysis. Conifers are much less dangerous than the woods of deciduous trees, such as oak, etc. Two species of insects, Syrax and Hylotrupes bajulas eat their way out of wood through lead sheathing. JDG (13)

Corrosion of Oil Tankers. N. B. Musser. *Proceedings American Petroleum Institute,* Vol. 13 (III), 1932, pages 51-62. Analysis of a large number of drill tests indicates that the average rate of penetration of hull steel on vessels in corrosive-oil service is about 0.006 in. per year on each surface exposed to oil. There is evidence that this rate is not constant, but accelerates during the life of the vessel. Based on this figure, in a little over 12 years a tanker in gasoline service would lose 30% of the thickness of 1/2-in. plating exposed to oil on both sides. Local conditions might cause considerable deviation from the average. An analysis is given of the distribution of corrosion between the various members in the vessel, classified as to position (horizontal or vertical), location (top or bottom), exposure (one or two sides), and service (corrosive or non-corrosive oils). It is indicated that about 3-1/2 years of non-corrosive service is equivalent to one year of corrosive service, based on average loss of metal alone; also that non-corrosive oils do not cause any greater corrosion than the average for structure not exposed to oil. Horizontal members appear to suffer more than vertical, and the top half of tanks in corrosive service more than the bottom half. Considering the shell plating alone, the worse corrosion occurs on bottom plates. Preventive measures, tried in the past, are discussed, and several yet untried are listed for future investigation. These include re-design of hull structures to secure a more uniform life for all members; also the use of cheap coatings applied by the crew at frequent intervals using equipment already available. VVK (13)

Corrosion Problems. A. B. Owles. *Electrical Review,* Vol. 114, May 18, 1934, pages 697-698. Discusses causes of and means of preventing corrosion of ferrous metals in economizers, boilers, superheaters, and turbines. Concludes that efficient de-aëration is a reliable safeguard against corrosion, and that a make-up H_2O as free as possible from chlorides, nitrates, and CO_2 be used. MS (13)



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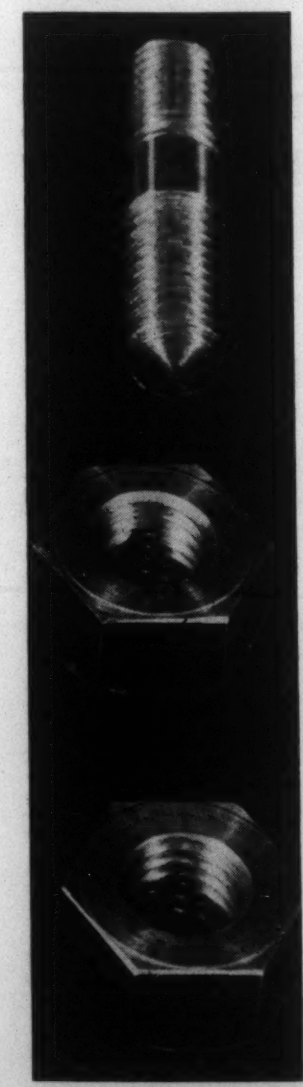

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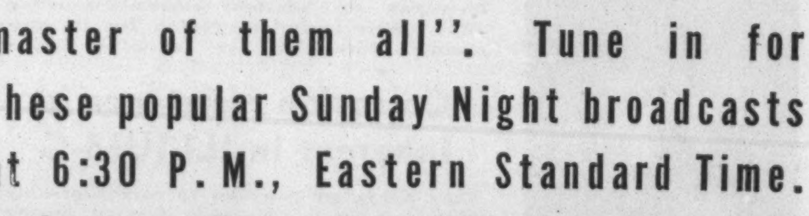

The Exothermic Phenomenon of Soft Steel Piece in Nitric Acid Solution and its Significance. Yôichi Yamamoto. *Bulletin Institute of Physical & Chemical Research, Tokyo,* Vol. 13, Mar. 1934, pages 195-234. In Japanese. *Scientific Papers and Abstracts of the Institute of Physical & Chemical Research, Tokyo,* Vol. 23, Mar. 1934, pages 17-19. In English. The exothermic phenomenon on steel immersed in HNO_3 increases with increasing concentration. Temperature rise takes place in two stages. The first is due to the direct oxidation of the steel surface by the oxidizing properties of HNO_3 and the second is due to the oxidization of the H_2 evolved on the dissolution of the soft steel itself. The corrosion velocity drops suddenly beyond the peak value on the exothermic curve. The amount of corrosion, increasing with increasing acid concentration, decreases suddenly above 47% HNO_3 and the steel becomes passive preserving its metallic lustre indefinitely. The corrosion velocity of the steel piece is accelerated by the temperature rise of the solution due to the exothermic reaction. This was verified by cooling the corrosion vessel. The point of the maximum temperature of the exothermic curve does not always mean the point of the loss of the oxidizing power of the HNO_3 solution. (See also *Metals & Alloys,* Vol. 4, Sept. 1933, page MA 281 9-L). WH (13)

The Passivity of Iron and Steel in Nitric Acid Solution. Yoichi Yamamoto. *Bulletin Institute of Physical & Chemical Research, Tokyo,* Vol. 13, May, 1934, pages 375-455. In Japanese. *Scientific Papers & Abstracts Institute of Physical & Chemical Research, Tokyo,* Vol. 24, May 1934, pages 26-28. In English. Specimens of soft Fe with .15 C, .14 Si, .037 P and .51 Mn were immersed in 300 cc. HNO_3 solutions. The most important factor in the appearance of the passivity phenomenon is the acid solution concentration and the next important one the temperature of the solution at the time of immersion. Samples became passive in solutions of above 49% HNO_3 at 20°C. At this critical concentration a periodic passivity due to the temporary activation of the steel surface takes place. The temperature change at the sample surface is attributed to the oxidation of hydrogen evolved by dissolution of Fe in HNO_3. The periodic passivity or the metastable state also occurs in the vicinity of the critical temperature. The latter rises with increasing acid concentrations. Steel samples immersed in acid solutions of above 72.5% HNO_3 do not become completely active even at the boiling point of that solution. (See also *Metals & Alloys,* Vol. 4, Sept. 1933, page MA 281 L9). WH (13)

Materials of Construction Trends. Lincoln T. Work. *Chemical & Metallurgical Engineering,* Vol. 40, Dec. 1933, page 628. Paper presented before the students' course of the Fourteenth Exposition of Chemical Industries, Dec. 8, 1933. The trend is toward more extended use of less common materials and toward greater economy through the use of coatings and through simplicity in fabrication. PRK (13)

The Corrosion of Iron (Sur la corrosion du fer). E. Toporescu. *Comptes Rendus,* Vol. 197, Nov. 6, 1933, pages 1040-1041. Starting with the idea that liquids are polymerised under the action of capillarity and that the polymerised molecules have considerable chemical activity, T. has sought to determine whether it would be possible to obtain rapid corrosion by causing solution to rise between two sheets of iron under capillary action. Experiments were carried out by T., using distilled water and 3% NaC1 solution. T. opines that his experiments indicate that oxidation depends, not upon differential aeration, but upon surface tension effects. OWE (13)

Report on Bureau of Standards Soil Corrosion and Pipe Coating Investigation. Leonard P. Wood. *Journal American Water Works Association,* Vol. 26, Feb. 1934, pages 176-188. Report to the American Water Works Association and the Sectional Committee on Specifications for Cast Iron Pipe. Review of progress to date. Conclusions (some by the author and others by the Bureau of Standards) drawn on bare pipe and fittings test after 8 to 10 years are: type and severity of corrosion of ordinary ferrous materials (except high silicon iron) are determined by the soil much more than by the material; no one of the rolled ferrous pipe materials has shown outstanding superiority in all soils at the end of 10 years; the cast irons average somewhat more loss of weight and depth of pitting than the rolled materials but generally not in proportion to the greater thickness of the walls of commercial pipe; in certain soils a particular ferrous material either rolled or cast shows a consistent superiority in loss of weight or rate of pitting or both throughout the 10 years but in many soils there is no important and consistent difference either throughout the test or at the end of 10 years; substantially all of the rolled and many of the cast materials after 10 years in the more corrosive 22 of the 47 soils and after 8 years in a few soils had suffered commercially important corrosion; pitting data are a direct measure of resistance to failure by perforation, loss of weight data indicate average weakening of pipe well but underindicate local weakening; in general annual increase in loss of weight and depth of pits in a given soil diminishes with time; working pipe lines in the same soils may show materially deeper pits and earlier perforation of the same thickness of metal than indicated by these small ferrous specimens; high silicon cast iron after 10 years showed small to negilgible loss of weight and no pitting in most soils; corrosion of high tensile cast iron, malleable cast iron and cast steel so far is not notably different from that of pit cast iron pipe. Conclusions drawn on metallic coatings on ferrous pipe are: lead coating showed deeper pitting than hot dip galvanizing in all of the 14 soils from which both were removed after 8 years; calorizing shows no advantage in pitting over hot dip galvanizing in excess of the probable experimental error in any of the 5 soils from which both materials were removed after 8 years, whether done by the wet or by the dry process, in 3 cases by one process and in 5 cases by the other it shows deeper pits than galvanizing; galvanizing has afforded very substantial protection of ferrous pipe in the 14 corrosive soils compared after 8 years; no significant difference in the galvanized specimens can be attributed to the base metals; in general the heavier the zinc coating the less the loss of weight and pitting. Lead cable sheath showed serious loss of weight and pitting in only a very few soils. Copper pipe (6-8 years in 8 soils) generally showed about 1/10 the loss in weight of the ferrous pipes. Conclusions drawn from the American Gas Association and American Petroleum Institute protective coating investigations are: thin paint films and unreinforced soft coatings are of very doubtful value, in any soil; there is marked increase in effectiveness of coating with increased thickness up to about 0.1 inch; asphalt emulsions are probably too soft to resist penetration by soil pressure; soil stresses are one of the most destructive agencies affecting coatings on the outside of buried pipes, thick hard enamels or reinforced or shielded coatings appear to be required. Practical applications of the data are discussed. VVK (13)

Controlling Corrosion of Distribution Systems. Abel Wolman. *Journal American Water Works Association,* Vol. 25, July 1933, pages 947-955. Aeration of the water supply to remove CO_2 followed by lime treatment was found successful in curing corrosion troubles in a number of small communities in Maryland covering a total population of between 25,000 and 30,000. VVK (13)

The Dissolution of Magnesium in Aqueous Salt Solutions. Part III. L. Whitley. *Transactions Faraday Society,* Vol. 29, Dec. 1933, pages 1318-1331. Contains bibliography. The initial corrosion rates of Mg in KCl, K_2SO_4, KBr & KI were found to be of the same order of magnitude, though there was a definite tendency for the dilute solutions to show a slightly higher initial rate of reaction than the concentrated solutions. Traces of Saponin decreased rate of solution, indicative that reaction is under anodic control. Calculations showed that there is a greater tendency for discharge of hydroxyl ions than for formation of metallic ions. The solubility of $Mg(OH)_2$ was studied, as well as relation between surface area and rate of attack of Mg in NaCl and Na_2SO_4 solutions. The results were shown to be in accord with primary preferential hydroxyl ion discharge theory of corrosion. This theory assumes that the initial anode reaction is not ion formation but discharge of hydroxyl ions (OH^-) which then combine with the metal to form protective films. PRK (13)

The Corrosion Problem with Respect to Iron and Steel. Frank N. Speller. *Metals Technology,* June 1934, American Institute Mining & Metallurgical Engineers, Technical Publication No. 553, 21 pages; *Engineer,* Vol. 157, June 29, 1934, pages 663-664. This is the Henry Marion Howe lecture delivered Feb. 1934. The importance of corrosion is pointed out and some of the factors governing corrosion are described. Methods of preventing corrosion are discussed. A plea is made for coöperative work. 20 references. LFM + JLG (13)

Comparative Results of Corrosion Measurements (Resultats compares de mesure de la corrosion). Jean Cournot & Henri Fournier. *Comptes Rendus,* Vol. 197, Dec. 4, 1933, pages 1409-1411. Comparison is made between the results of Siebel and Pomp cupping tests, Persoz cupping tests, and loss of weight tests, all designed to measure the effects of corrosion on the following products: pure Armco iron, 18-8 stainless steel, 34% nickel steel, duralumin, Monel metal, 67% brass. The products were treated as received and after two months' subjection to salt spray. Results are tabulated. OWE (13)

Determination of the Corrosion Effects by Lowering of the Values Obtainable with KWI Cupping Test (Sur la mesure des effets de corrosion par l'abaissement des caractéristiques d'emboutissage KWI). J. Cournot & H. Fournier. *Revue de Metallurgie,* Vol. 31, May 1934, pages 198-200. Armco Fe, 18-8 steel, 34% Ni steel, duralumin, Monel metal and brass were tested by KWI and Persoz methods. Average of 10 tests was used. No definite relation between the cupping values and corrosion were found though KWI method appears to be better for non-ferrous alloys than Persoz's. JDG (13)

Wear Resistance of Cylinder Cast Irons. A. Wallichs & J. Gregor. *Foundry Trade Journal,* Vol. 50, Feb. 22, 1934, page 138. Extended abstract of article which appeared in *Die Giesserei.* See "Investigations of Wear of Different Kinds of Cast Iron for Automobile Cylinders by Wear Testing Machines and Automobile motors," *Metals & Alloys,* Vol. 5, June 1934, page MA 292. OWE (13)

Valve-Seat Wear. C. G. Williams. *Mechanical World & Engineering Record,* Vol. 95, Mar. 23, 1934, pages 271-272; *Engineering,* Vol. 137, Feb. 23, 1934, pages 245-247. Deals with a report of the research department of the Institution of Automobile Engineers. Discussion of the test equipment. The composition of the valve-seat inserts used in the tests is given as follows: 3.33% C, 0.59% C.C., 2.05% Si, 0.58% Mn, 0.43% P, 0.29% Cr, 0.10% Ni. Brinell hardness was 210. Tests showed that the valve sinkage was very largely due to actual seat wear, and that it increased about eightfold with an increase in tappet clearance from 0.006" to 0.020". Seat wear increased rapidly from 650°-750°C., but decreased sharply above 750°C. Wear was almost independent of valve-seat area. With valves of silchrome steel, sinkage was almost entirely due to "dishing" of the valve-head. Measurements of valve and seat temperature were made on some modern engines, the maximum temperature ranging from 642°-810° C. Temperatures were reduced by extending the valve guide towards the valve-head, by increasing the valve-stem diameter, and by using Cu as valve-guide material. An A1 head reduced valve and seat temperatures. Kz (13)

Wear of High-Duty and Alloy Cast Iron. R. Knittel. *Foundry Trade Journal,* Vol. 49, Oct. 26, 1933, page 238. Extended abstract of article which appeared in *Die Giesserei.* See "Investigations on the Wear of High-Grade Gray Castings and Alloyed Gray Castings with Consideration of the Requirements for Pistons and Cylinders of Combustion Motors," *Metals & Alloys,* Vol. 5, June 1934, page MA 299. OWE (13)

The Question of Wear in Cylinders of Combustion Motors (Beiträge zur Frage der Zylinderabnutzung bei Verbrennungsmotoren). W. A. Ostwald. *Automobiltechnische Zeitschrift,* Vol. 37, May 10, 1934, pages 246-247. The reasons given for wear of cylinders according to investigations of several authors are reviewed, in particular experiments by Ricardo and Institute of Automobile Engineers. Ha (13)

Boiler Diseases. T. E. Purcell & D. S. McKinney. *Electric Light & Power,* Vol. 12, Apr. 1934, pages 28-30, 33-34. Elementary discussion of conditioning boiler feed—H_2O. Includes brief consideration of corrosion of metal. MS (13)

Macroscopic Testing by Means of Colors Produced by pH Indicators (Essais de macroscopie colorée par les indicateurs de pH). Prot & N. Goldowski. *Revue de Métallurgie,* Vol. 31, May 1934, pages 214-218. Much light can be thrown on the mechanism of corrosion by determining the polarity of different areas of a specimen. Adding to a 10% gelatine solution of the electrolyte a universal pH indicator and observing the colors produced permits this easily. The solution is applied with a brush or as a spray and the image develops in a few hours. The universal pH indicator proposed is composed of: cresol-phthalein 1.60 g., phenolphthalein 0.50 g., bromthymol blue 0.40 g., methyl red 0.40 g., naphtolphthalein 0.32 g., methyl-orange 0.10, alcohol at 70°C 100.0 g. The image is recorded photographically by the use of proper color filters. JDG (13)

Remarks on Preparation of Sheet Corrosion Specimens (Remarque concernant la preparation des éprouvettes de corrosion sur tôles). Albert Portevin. *Revue de Métallurgie,* Vol. 31, May 1934, pages 212-213. Cutting specimens before corrosion creates conditions resulting in entirely different physical properties on testing them in the specimens machined after corrosion. JDG (13)

Deterioration of Chromium-Tungsten Steels in Ammonia Gases. Peter R. Kosting. *Metals & Alloys,* Vol. 5, Mar. 1934, pages 54-56. Exposure of steels of varying Cr and W content to H_2 and N_2 in ratio of 3:1 and 10% NH_3 at 300°C. and 600 atmospheres show intergranular corrosion in steel of 0.81% W decreasing with increasing W up to 2.85% above which further addition was without benefit. As much as 11.69% was detrimental. 1% of Cr was very beneficial in preventing this type of attack. C content should not be greater than 0.35%. Exposed slag is attacked and pitting results. WLC (13)

Pipe-Line Maintenance Costs Cut by Cathodic Protection. E. S. Knox & H. J. Keeling. *Electrical World,* Vol. 113, Mar. 17, 1934, pages 392-395. Cathodic protection of pipe lines at an outlay of 1.6 to 3.1 per cent of the cost of the lines saves the cost of reconditioning the protective coating, which is half or more of the original cost, at the end of a 10 year period. A mile of new pipe can be protected at an annual outlay of $15 to $25. Wth a.c. service available near a new pipe line an inexpensive rectifier readily supplies the few amperes needed at 5 volts or less. Elsewhere a gravity battery has been used. Up to 10 miles has been drained by a cathodic unit. CBJ (13)

Resistance to Intercrystalline Corrosion of Acid-Resistant and Hardenable Chromium-nickel Alloys (Ueber den Widerstand säurebeständiger und vergütbarer Chromnickel-Legierungen gegen interkristalline Korrosion). W. Hessenbruch & E. Horst. *Heraeus Vacuumschmelze,* 10th Anniversary Volume, 1933, pages 233-246. Contracid alloys containing Ni 60-62, Cr 12-15, Fe 13-15, Mn 1.5-2, Si 0.4-0.6, Mo 7 (or Mo 3, W 4), Co 0-3, and Be 0-0.8% are practically unattacked by 10% HCl, HNO_3 or H_2SO_4, even after cold-working and annealing at not above 1000°C., or after precipitation-hardening; whereas the 18:8 Cr-Ni steel shows a much higher rate of corrosion in these acids after annealing at 500°-800°, because of intercrystalline penetration of the acid caused by local elements set up by precipitation of constituents from solid solution along the grain boundaries. (13)

Corrosion Resisting Malleable Iron Now Finding Many Uses in All Branches of Oil Industry. Rebecca Hall. *Oil & Gas Journal,* Vol. 32, Feb. 22, 1934, page 54. A new alloy iron, called Lakalloy No. 7, the analysis of which is not given, is compared with malleable iron for solubility in sulphuric, hydrochloric, nitric and acetic acid. Less corrosion is claimed for No. 7 for all of these and it is recommended particularly for sulphuric acid conditions. VVK (13)

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Sulphur-resistant alloys (Ueber schwefelbeständige Legierungen). H. Ipavic. *Heraeus Vacuumschmelze,* 10th Anniversary Volume, 1933, pages 290-302. Ni-Cr alloys with more than 50% Ni are rapidly corroded by H_2S at high temperature by intercrystalline penetration of Ni_3S_2. Under similar conditions Cr-Fe alloys with more than 30% Cr become covered with a thin protective sulphide firm (I) which does not diffuse into the metal. Cementation with Si or Al does not prevent formation of (I). The behavior of both types of alloys in atm. containing SO_2 at high temperature is similar to that in H_2S, but the action is much slower. (13)

The Passivity of Magnesium in Solutions of Chromic Anhydride and Its Chemical Cleaning after Corrosion (Sur la passivité du magnésium dans les solutions d'anhydride chromique et sur son décapage chimique après corrosion). Marcel Chaussain & Henri Fournier. *Comptes Rendus,* Vol. 198, Mar. 12, 1934, pages 1035-1037. Boiling solutions of chromic anhydride have been successfully used to remove the products of corrosion from the surface of magnesium, but inconsistent results are obtained with 99.8% Mg (rolled and annealed) unless precautions are taken to counteract the effects of such sulphuric acid as may be present in the anhydride. Mg is no longer passive when the sulphuric acid content of 15% chromic anhydride solutions exceeds about 1 g. per litre. If, however, barium chromate is added to such solutions in sufficient quantity to neutralize the acid, passivity can be restored. OWE (13)

Chemical Methods of Cleaning Light and Ultra-light Metals after Corrosion (Sur les méthodes chimiques de décapage des métaux légers et ultra-légers après corrosion). Marcel Chaussain & Henri Fournier. *Comptes Rendus,* Vol. 198, Mar. 5, 1934, pages 936-939. It has been generally assumed that nitric and chromic acids, while satisfactorily dissolving the products of corrosion of light and ultra-light alloys, have little effect upon the metals themselves. This, however, is not true, the passivity of aluminum and its alloys being not complete in nitric acid, the loss in weight of the corroded material increasing with time of pickling and with the degree to which corrosion had proceeded prior to pickling. Loss of weight measurements should therefore be conducted under identical conditions in so far as pickling is concerned, and corrections should be made for errors likely to occur during the pickling operation. A simple method, giving good results, involves: (1) pickling of the test pieces for 15 or 20 minutes in concentrated nitric acid at 60-70° C., and determining their weight, p; (2) repeating the operation for the same time and redetermining their weight, p_2. The original weight (p) of the metal is given by the equation $p = 2p - p_2$. OWE (13)

Treatment of Flood Waters in Bradford Field for the Removal of Corrosive Suspended Matter. L. J. Clarke. *Oil & Gas Journal,* Vol. 32, Jan. 11, 1934, pages 16,18. The treatment of flooding water with lime to prevent corrosion and to remove suspended matter has been practiced in the Bradford Field in McKean County, Pa., and Cattaraugus County, N. Y., with very satisfactory results from the standpoint of cost and of oil production. VVK (13)

The Assessment of Corrosion Damage. *The Industrial Chemist,* Vol. 10, May 1934, pages 170-172. This article is Part II of an article, "The Usefulness of Corrosion Tests to the Chemical Engineer," which appeared in an earlier issue of this journal. 15 references. A resumé of previously published work on the measurement of corrosion damage and the application of such measurements. RAW (13)

APPLICATIONS OF METALS & ALLOYS (14)

Non-Ferrous (14a)

G. L. CRAIG, SECTION EDITOR

Application of Metal Sheets for Surveying Plans. R. McAdam, John S. Reid & James K. Templeton. *Colliery Guardian,* Vol. 147, June 14, 1933, pages 67-68. Paper before Institution of Mining Engineers, Edinburgh, 1933. See *Metals & Alloys,* Vol. 5, May 1934, page MA 232. VVK (14a)

Composition of Zinc for Polygraphic Type Plates. M. D. Zudin *Tzvetnuie Metallui,* Jan. 1933, pages 100-103. In Russian. Gives compositions of domestic and imported Zn for type plates. Hardness and fine grain are obtained by adding small amounts of Cd (up to 0.5%). Melting in induction furnace is recommended. BND (14a)

Corrosion-Proof Conduit. *Platers' Guide,* Vol. 30, Apr. 1934, page 23. The use of Everdur alloy offers the following advantages: immunity from rusting; resistance to many corrosive agents and to shock and stress; strength of mild steel, and long life in applications where high humidities exist. WHB (14a)

Food Manufacturing Equipment: Extended Use of Pure Nickel. *Chemical Age,* London, Vol. 29, July 8, 1933, pages 23-26. Illustrated exposition of the use of Ni in machinery for food preserving and allied uses. VVK (14a)

Ferrous (14b)

M. GENSAMER, SECTION EDITOR

Large Uses of Steel in Small Ways. No. 263. Chipping Hammers. *Steel,* Vol. 94, June 18, 1934, page 46. Manufacture of pneumatic chipping hammers requires more than 100 tons of alloy steel annually, principally bars and forgings. MS (14b)

Large Uses of Steel in Small Ways. No. 264. Can Openers. *Steel,* Vol, 95, July 2, 1934, page 37. About 5,000,000 units of the various designs of can-openers are produced annually in the U. S. These require about 300 tons of steel, principally in the form of cold-rolled strip. Other products used are tool-steel and wire. MS (14b)

Completes Shop Fabricated Steel House in Wheeling. *Steel,* Vol. 94, Apr. 23, 1934, pages 28-29. Gives details of construction of residence. See also "Prefabricated Sections used in New Steel Residence," *Metals & Alloys,* Vol. 5, June, 1934, page MA 298. MS (14b)

Manufacturing "Knee-Action" Spring Suspensions. A. H. Allen. *Steel,* Vol. 94, June 18, 1934, pages 31-34; June 25, 1934, pages 27-30. Describes the materials, methods, and equipment used in the manufacture of independent springing systems. Open type is used on the heavier and more expensive cars while the enclosed type is used on lighter cars. Manufacturer of latter was described by John M. Bonbright in *Heat Treating & Forging,* Vol. 20, Mar. 1934, pages 117-120. MS (14b)

Steel Castings for Boulder Dam. Pat Dwyer. *Foundry,* Vol. 62, June 1934, pages 14-17, 42. Describes the manufacture of some of the large steel castings for Boulder Dam by the Machined Steel Casting Co., Alliance, O. Steel for the castings was melted in a 25-ton acid-lined, oil-fired open-hearth furnace. The metal was plain C steel with tensile strength of 70,000 lbs. per sq. in. and composition of 0.28% C and Mn 0.80%. Cast steel flask parts are assembled to suit requirements of any mold. 3-in. diam. sprue extended from top of mold where gates were formed. Core made and dried in 8 sections and assembled in mold. VSP (14b)

Development of Sucker Rods and Pull Rods Being Advanced by New Heat-Treating Installation. R. C. Conine. *Oil & Gas Journal,* Vol. 32, Feb. 22, 1934, pages 42-43. Development of the sucker rod from the wooden rod with wrought iron wing type joints to the present extra high strength sucker rod for highly stressed deep well pumping is traced and a description given of the manufacture of three types of rods. VVK (14b)

Locomotive Crank Axles. F. L. Baxter. *Engineer,* Vol. 157, June 29, 1934, pages 646-648. Gives table showing physical properties of materials used for crank axles by different railways in England, Japan, Spain and the United States. Remainder of article deals mainly with design. LFM (14b)

Propose Unusual Steel Exposition Buildings. Leon Jaudoin. *Steel,* Vol. 94, May 7, 1934, pages 28-29. Outlines prize winning designs submitted in a French competition for a hall to cover a rectangular area of 29.69 acres, without any intermediary support. Pays chief attention to the scheme of Baudouin and Lotz, which was ineligible for a prize. This proposed a circular hall involving 63,000 tons of steel. Frame is designed as a sort of inverted dome with an assembly under tension, equilibrated by an exterior belt which is under compression and which is supported by four double consoles, similar to springs. MS (14b)

New Developments in Valve Springs for Gas Engines. Karl Pfeiffer. *Metal Progress,* Vol. 25, June 1934, pages 34-38. Requirements upon steel for valve springs have become more severe with increasing engine speeds. Design is arrived at by cut and try methods which have shown that length should be twice diameter when valve is in closed positions and that ratio of coil to wire diameter should be from 5.5 to 7. For speed prevalent 10 years ago a hard drawn, patented wire of C steel was satisfactory but with valve gear speed of 1500 r.p.m. and over stronger material was required. Oil tempered C wire of American manufacture was found unsatisfactory on account of non-uniformity of structure and mechanical properties and mechanical defects. S.A.E. 6150 was then adopted but with discouraging results due to epidemics of failures traceable to surface imperfections. Efforts to eliminate this trouble have been only partially successful and many companies have discarded this material. A Swedish C steel has been developed of properties comparable to the alloy steel and consistently free from the mechanical defects. Surge results from a resonant condition between the rate of forced vibration due to camshaft and the natural frequency of the spring and is the cause of faulty engine operation, noise and failure of spring. Several attempts to eliminate this effect have been made by making a spring of uniform pitch and high rate, by combining two such springs coaxially and equally spaced, by increasing the pitch one end to other or both ends to the center. Static and dynamic tests of wire and springs and deep etching for surface defects in wire are discussed. Effect of corrosion on fatigue life of springs is discussed and effect of proper crankcase ventilation in reducing corrosion cited. WLC (14b)

Dairy Equipment of Stainless Steel. F. L. Prentiss. *Iron Age,* Vol. 133, Apr. 5, 1934, pages 20-23, 82. Discusses the manufacture of dairy equipment using 18-8 Cr-Ni stainless steel and welding. VSP (14b)

Electrical Strip—A New Product. F. L. Prentiss. *Iron Age.* Vol. 132, Nov. 2, 1933, pages 18-20. The process includes special heat treatments in controlled atmosphere in a continuous type electric furnace. The strip is made of steel containing Si from 4.5 down to 0.5% and is hot rolled to an intermediate gage and then cold rolled to finish gage. The first heating operation is at about 1900° F. The second heat treating in continuous furnace is at 1450 to 1500° F. Speed of strip through furnace is automatically controlled. VSP (14b)

Manufacturing Appliances for Household Use. J. B. Nealey. *Steel,* Vol. 94, Apr. 2, 1934, pages 23-24. Describes plant for the manufacture of electric and gasoline washing-machines and power press irons. MS (14b)

Interlocking Steel Sheet Piling on Jetty at Nome Staves off Arctic Ice. John R. Noyes. *Steel,* Vol. 94, Apr. 23, 1934, pages 32, 34. Steel sheet piling in 34-ft. lengths has been driven at a 34° angle to replace in part a timber jetty. Change to steel was made to insure greater strength and permanence together with decreased maintenance cost. MS (14b)

High Strength Alloy Castings for Cranks. A. F. Moyer. *Metal Progress,* Vol. 25, May 1934, pages 27-29. A cast iron made in cupola with 18% steel scrap in charge to analysis total C 3.30-3.40%, Si 1.70%, Mn 0.60-0.80%, P 0.20%, Ni 2.00%, Cr 0.75% shows a Rockwell hardness of B 97-101 and is being used for casting automotive crankshafts using very carefully control molding, melting, and pouring technique. WLC (14b)

Ford's Experience With Rustless Steel. J. L. McCloud. *Iron Age,* Vol. 132, July 13, 1933, pages 10-11, 60. Abstract of a paper read before the Springfield and Worcester, Mass. chapters of the American Society for Steel Treating. Describes the problems encountered by the Ford Motor Co., in using rustless, particularly the so-called 18 and 8 and 18 alloys. Emphasizes the importance of grain size which seems to influence the smoothness of drawn parts, the use of special dies for drawing operations and the avoiding of extra work in polishing finished stampings. VSP (14b)

Difficult Problem of Selecting Alloys Steels. H. W. McQuaid. *Blast Furnace & Steel Plant,* Vol. 22, Jan. 1934, pages 63-67. *Heat Treating & Forging,* Vol. 20, Jan. 1934, pages 15-18, 21. From the author's discussion of the applications of alloy steels to automotive parts, it is apparent that there is no unanimity regarding the best alloy steel for a given part. This indicates that there is little to choose between most of these steels and that the difference between them can be determined only by a relatively large scale investigation. In selecting a steel for a given purpose, a careful study must be made of every step in the processing and it is necessary to know the effect of the alloying elements on the reaction of the part to any of the steps in processing. Among the important factors which must be considered are cost; soundness and surface defects of the bar; shearing properties; reaction to normalizing, pickling, and selective drawing; relative machinability; heat treatment required; hardening, distortion, and cold straightening characteristics; tendency to crack in quenching; etc. Gives some examples of the effects of alloying elements and C. MS (14b)

Rehabilitation of a 3,750-kva. Turbo-Generator. J. H. Siegfried. *Electrical West,* Vol. 72, June 1934, pages 118-119. A report of the Production and Generation Committee, Engineering and Operation Section, Northwest Electric Light and Power Association. Stainless steel blades replaced eroded blading. MS (14b)

Steels for Automobiles. (Pt. 1). J. W. Urquhart. *Heat Treating & Forging,* Vol. 20, Jan. 1934, pages 32-34. This part is the same as *Blast Furnace & Steel Plant,* Vol. 21, March 1933, pages 159-160, 170. See *Metals & Alloys,* Vol. 5, Jan. 1934, page MA 14. MS (14b)

Steels for Automobiles. Pt. II-IV. J. W. Urquhart. *Heat Treating & Forging,* Vol. 20, Feb. 1934, pages 73-75, 79; Mar. 1934, pages 125-127; Apr. 1934, pages 176-177, 184. Title varies. Continues summary of tests conducted by the Springs Research Committee on bending fatigue limits of laminated springs. Outlines composition, physical properties, and heat treatment of steels for the various parts of the engine, transmission, and chassis of European racing-cars. MS (14b)

Alloys for Springs with a Low Temperature Coefficient of Elastic Modulus (Ueber Legierungen für Federn mit kleinem Temperatur koeffizienten des Elastizitätsmoduls). R. Straumann. Heraeus Vacuumschmelze, 10th Anniversary Volume, 1933, 408-423. A non-rusting, non-magnetic alloy with a high elasticity and low temperature coefficient of elasticity for the manufacture of watch and clock springs is made by adding to 100 parts of a 33:67 Ni-Fe alloy W 8 (or Mo 6) parts, Be 1, Mn 0.8, and Si 0.1 part. Such a spring with an anisotropic Ni-Ag balance wheel provides an accurate timing system over a wide temperature range. A non-rusting alloy for mainsprings of clocks and watches contains Ni 60, Cr 15, Mo 6.5, Fe 15, Be 0.65, and Mn 2%; the springs can be hardened by heat-treatment (precipitation-hardening) without becoming brittle. (14b)

On the Application of Cold Rolled Steels in Reinforced Concrete Construction (Zur Frage der Verwendung kaltgereckter Stähle im Eisenbetonbau). J. Wanke. *Der Bauingenieur,* Vol. 15, Jan. 19, 1934, pages 32-33. Aging and changes in cold rolled steels caused by temperature variation are considered, suspected reasons for not applying such steels as reinforcing material in concrete constructions are enumerated. GN (14b)

Better Gas Engines, Automobile, Aircraft, Diesel. G. D. Welty. *Metal Progress,* Vol. 25, Apr. 1934, pages 28-31. Use of Al alloys in automobiles has increased mainly because Al piston and cylinder heads give improved smoothness of performanace. In aircraft the weight consideration is most essential, Al crankcases, nose and rear sections for radial engines, cylinder heads, pistons, and link rods make possible an engine weighing only 1 lb. per developed hp. In diesel engines the use of Al to lighten the reciprocating parts has made possible greater speed in the same dimensions. WLC (14b)

Modern Locomotives Seldom Fail from Poor Metal. Frederick H. Williams, *Metal Progress,* Vol. 25, April 1934, pages 23-27. Comment regarding the effect of machine finish and corrosion upon the failure of locomotive parts. Use of alloy steels would be less frequently adopted if proper attention were given to these factors. Heat treatment of carbon steel axles, utility of McQuaid-Ehn tests in selection of C steels, the place of castings and welding in railroad motive power construction are discussed. WLC (14b)

Selection of Ferrous Metals Used in Refineries Has Developed to Paramount Importance. E. C. Wright. *Oil & Gas Journal,* Vol. 31, Oct. 6, 1932, pages 57-59. Paper before Mid-Continent meeting A.S.M.E., Oct. 1932. VVK (14b)

Steels in Marine Engineering Service-Modern Requirements and Specifications. T. H. Burnham. *Foundry Trade Journal,* Vol. 59, Jan. 25, 1934, page 76. Extended abstract of paper read by Burnham at meeting of Institute of Marine Engineers (Jan. 9, 1934). See *Metals & Alloys,* Vol. 5, June 1934, page MA 299. OWE (14b)

GENERAL (15)

RICHARD RIMBACH, SECTION EDITOR

Review of Iron and Steel Literature for 1933. E. H. McClelland. *Blast Furnace & Steel Plant,* Vol. 22, Jan. 1934, pages 41-42; Feb. 1934, pages 103-105, 113. 17th annual classified list of the more important separately published books and pamphlets of the year with a few of earlier date not previously announced. The list, with additions, will be reprinted by the Carnegie Library of Pittsburgh and may be obtained free at the Library or for 5 cents post-paid. MS (15)

French Prefer the Term "Special Steel." Albert Portevin. *Metal Progress,* Vol. 26, July 1934, pages 47-48. Gives conventions of French steel nomenclature. WLC (15)

"Body" of Ale, Bar Iron and Tool Steel. Bernard Collitt. *Metal Progress,* Vol. 25, June 1934, pages 52-53. Reaumur in 1722 discussed the term "body" as applied to steel and stated that it is the property which hardened steel possesses of resisting breakage. Brearley in more modern book applies the term to two of the raw materials as well, ale and wrought iron bar. "Body" of its raw materials need not be inherited by steel. WLC (15)

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OLYMPIC
BRONZE

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and corrosion-resistant alloy, it
can be used on screw machines.

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Manganese: Its Occurrence, Milling, and Metallurgy. Part I. Physical Properties and Prenaration of Metallic Manganese. R. S. Dean. *United States Bureau of Mines, Information Circular* No. 6768, May 1934, pages 3-7.—A review. **Manganese in Nonferrous Alloys.** R. S. Dean. *Ibid.* pages 9-13. A review. **Compounds of Manganese.** R. S. Dean. *Ibid.* Pages 15-21. A review, including uses. **Occurrence and Ore-dressing Possibilities of Ores of Manganese in the United States.** Fred D. DeVaney & Will H. Coghill. *Ibid.* Pages 23-98. Of 116 Mn ores from 20 states examined to determine their amenability to concentration, 20 can be concentrated to meet all requirements for ore suitable for the manufacture of standard 80% ferro Mn. and 43 can be used in production of spiegeleisen. Mn oxide and carbonate minerals can be separated from gangue by flotation (usually in an alkaline circuit) using fatty acids of fatty acid soaps and suitable conditioning agents, such as Na silicate, and a frothing agent. Details of concentration tests on ores from 17 districts are given. **Part II. Thermodynamic Properties of Manganese, and Its Metallurgically Important Compounds.** C. G. Maier. *United States Bureau of Mines. Information Circular* No. 6769, May 1934, pages 99-163. Thermodynamic data for Mn and its compounds are assembled, reviewed critically, and the results tabulated. **Part III. General Metallurgy of Manganese.** R. S. Dean. *United States Bureau of Mines, Information Circular* No. 6770, May 1934, page 165. A review. **Hydrometallurgy of Manganese.** Edmund S. Leaver. *Ibid.* Pages 167-191. The author discusses dissolution of Mn minerals and ores in H_2SO_3, the Bradley process ($(NH_4)_2 SO_4$ leach of roasted ore), the Sweet process (sulphatizing Mn followed by leach), the Leaver drum-leaching process (dissolution in hot H_2SO_3), Westling nitrate process (digestion with SO_2 and air to produce sulfates), electrolysis of $MnSO_4$ solution, precipitation of MnO_2 by O_3, and byproduct processes. **Pyrometallurgical Treatment of Manganese Ores.** T. L. Joseph. *Ibid.* Pages 193-252. Tests in an experimental blast furnace, a small open-hearth, and a small electric furnace (arc type) have demonstrated that ferro-Mn can be produced from manganiferous Fe ores by a 3 step process: 1. Smelt the ore as in spiegeleisen practice. The metal contains Mn 12-15, P 0.5 and Fe about 80%. 2. High P spiegel from (1) is treated in the basic open hearth or basic electric furnace. Fe ore is added (in excess) to oxidize Mn and get it into the slag. P also enters slag. There is enough difference in the rate of reduction of $Fe_3 (PO_4)_2$, FeO and MnO to permit adjusting Fe and P (with a comparatively small return of Mn to metal) using a 2-3 in. layer of coke. When the slag contains 25-35% FeO it is very fluid; as the FeO is lowered to 6-8% and MnO is increased to 60-70%, the slag becomes very viscous unless SiO_2 or Al_2O_3 is added. 3. Slag containing MnO 60-70, FeO 5-6, and $SiO_2 + Al_2O_3$ about 20% was treated in the experimental blast furnace to give ferro-Mu. Operation was more satisfactory on slags fluxed entirely with SiO_2. The slag is less desirable chemically than the imported ores from which ferro-Mn is now produced. **Part IV. Ferrous Alloys of Manganese and Their Use in the Steel Industry.** G. R. Fitterer & M. B. Royer. *United States Bureau of Mines, Information Circular* No. 6771, May 1934, pages 253-308. A review, with emphasis on phase relationships. **Part V. Bibliography.** *United States Bureau of Mines, Information Circular* No. 6772, May 1934, pages 309-334. Includes 405 references. **Indexes.** Mabel E. Winslow. *Ibid.* Pages 335-354. AHE (15)

The Manufacture of Drill and Other High Grade Steels at Vereeniging, Transvaal. J. H. Dobson, G. Robson, J. Burnard Bullock & H. Clarke. *Journal of the Chemical Metallurgical & Mining Society of South Africa,* Vol. 34, Feb. 1934, page 275. **Steel Manufacture in the Transvaal. Special Reference to High Grade Steels.** *Foundry Trade Journal,* Vol. 50, Feb. 22, 1934, page 134 (abstract). See *Metals & Alloys,* Vol. 5, June 1934, page MA 300. AHE+OWE (15)

Economic (15a)

A Steel Trade Constitution. *Engineer,* Vol. 157, Apr. 13, 1934, page 379. Editorial commenting on the revised constitution drawn up by a Committee of the National Federation of Iron and Steel Manufacturers. Objection is made that there is still no provision made for plant reorganization and reconditioning of obsolete equipment. The name of the organization has been changed to the British Iron and Steel Federation. See also continuation of discussion in editorial entitled "Steel Plans and Problems" in *Engineer,* Vol. 157,, June 29, 1934, page 657. LFM (15a)

Economic Results of Metallurgy, Recent and to Come. SAMUEL L. HOYT. *Metals & Alloys,* Vol. 5, June 1934, pages 113-117. Traces economic association of metallurgy with developments of automobiles, incandescent lamps, radio, naval and railroad facilities. WLC (15a)

Farmers Buying More Steel Fencing; Survey Shows Needs Are Heavy. A. J. HAIN & W. G. GUDE. *Steel,* Vol. 94, June 11, 1934, pages 31-33. In 1933, agriculture and cattle raising consumed 204,736 gross tons of wire products, the great bulk of this being fences. Survey indicates that sales in 1934 to agricultural interests should be more than double those in 1933. Square mesh type represents a larger tonnage than any other. Best market is in the Middle West. Steel posts are gaining favor steadily. MS (15a)

Progress in the Foundry in 1933. H. M. LANE. *Iron Age,* Vol. 133, Jan. 11, 1934, pages 23-24. Trend of events during past year has been against development of new foundry equipment. Little progress made in matter of molding machines. Considerable progress was made in metallurgy. In the making of the new types of steel careful metallurgical control and proper heat treatment is practical. Quick anneal malleable product makes possible obtaining a high-strength ductile casting in shorter time than the old malleable process afforded. In steel casting field the tendency is towards alloyed material. Michigan Steel Castings Co. has brought out a line of fittings for coupling stainless steel tubing. Oil and gas fired furnaces are being revived. VSP (15a)

Estimated Production of Steel for Replacements and New Uses. DAVID M. POLAK. *Iron Age,* Vol. 133, Apr. 5, 1934, pages 24-26. Due to decrease in population predicts a decrease in use of steel for replacements and new uses. Includes tables showing estimated production of steel for replacements and new uses 1859-1970. VSP (15a)

Mechanization and the Unemployment Problem. W. T. KITCHING. *Foundry Trade Journal,* Vol. 49, Oct. 19, 1933, page 225. General. OWE (15a)

Metallurgical Achievements in 1933 Augur Well for Industrial Progress. T. W. LIPPERT. *Iron Age,* Vol. 133, Jan. 11, 1934, pages 18-22. In line with exacting demands, plant and theoretical metallurgists have not only developed metals to meet rigid specifications, but in many cases have anticipated machine and metal requirements. Study of Fe and steel production by direct processes steadily advanced. U. S. Bureau of Mines reports direct reduction of $FeWO_4$ ores for use in production of high-speed steel. Advance in melting practice have made gray Fe available with tensile strength up to 60,000 lb./in.^{2} Status of magnetic hardening of steels continues to be somewhat in doubt. Graded quenching and tempering is gaining favor. Medium Mn steels are being used for cheap products. Alloy steels are finding increased application in structural members. Both German and American investigators made advances in metallurgy of tool steels. Includes information on a number alloys developed during the past year. VSP (15a)

The Training of Foundrymen—With Special Reference to the Future Welfare of the Industry. H. A. MACCOLL. *Foundry Trade Journal,* Vol. 50, Jan. 11, 1934, pages 23-25. MacColl suggests that the future welfare of the foundry industry depend upon (1) the recruiting of a better class of apprentice, (2) recognition of employers of their moral obligations to train their apprentices, (3) adoption of one definite examination as the standard of theoretical proficiency desirable in the skilled workman, and (4) support for any scheme which will increase the facilities for high-grade training suitable for the future foundry executive. OWE (15a)

A Projected British Foundry School. J. G. PEARCE. *Foundry Trade Journal,* Vol. 50, Mar. 22, 1934, pages 197-199, 202. Pearce discusses developments which have taken place in the foundry industry in Great Britain and deals with the activities of the British Cast Iron Research Association in so far as foundry education and training are concerned. The projected establishment at the University of Sheffield of a degree course in founding is discussed in detail. OWE (15a)

Long Term Outlook in Iron and Steel. DAVID M. POLAK. *Iron Age,* Vol. 133, Mar. 8, 1934, pages 12-19. Analysis of production of Fe and steel by decades, between 1870 and 1930 brings to light the fact that the rate of growth is slowing down. Although use of steel will increase in future the average annual increase will diminish. Includes charts and tables showing future trend. VSP (15a)

Practical Brass Foundry Costs. THOMAS H. WILLIAMS. *Metal Industry,* N. Y., Vol. 32, Jan. 1934, pages 10-11. A simple cost system developed by the Metropolitan Brass Founders Association is described. PRK (15a)

The Foundry Pig-Iron Industry in 1933. BEN WALMSLEY. *Foundry Trade Journal,* Vol. 50, Jan. 18, 1934, page 62. Article accompanied by 2 diagrams which indicate the improvement in production of pig iron in the United Kingdom during 1933. OWE (15a)

The Aluminium Foundry Industry. I. D. TAVERNOR. *Foundry Trade Journal,* Vol. 50, Jan. 18, 1934, pages 41-42. Article deals with interesting improvements which have taken place in the magnesium alloys of aluminum in the cast form, with foundry equipment, and with the production of anodic finishes on aluminum alloy parts for protective and decorative purposes. Some attention is given to the question of secondary metal in this industry. OWE (15a)

The Steel Trade: British and Foreign. E. T. GOOD. *Engineer,* Vol. 157, Jan. 19, 1934, pages 65-66. Gives some production and import and export figures. States that the U. S. which has large iron ore and coal resources is beaten in exports by Britain, France, Germany and Belgium. From being first in production and second in exports 30 years ago, U. S. competition in world's market has fallen to a low ebb. LFM (15a)

Trade Conditions in 1933 in the Grey-Iron Foundry Industry. W. H. HARPER. *Foundry Trade Journal,* Vol. 50, Jan. 19, 1934, page 45. Harper discusses the improvement in industrial conditions in Great Britain as they have affected the gray iron foundry industry and discusses also the change which has resulted from the alteration in the British fiscal policy whereby Continental and American manufacturers, who previously exported their finished goods to Great Britain, are now manufacturing there and buying their castings from British foundries. OWE (15a)

Mercury Industry in 1933—Advance Summary. H. M. MEYER. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 280, May 9, 1934, 2 pages. Domestic Hg production for 1933 declined 26% in quantity and 24% in value to 9,402 flasks worth $556,852. Imports in 1933 were 22,555 flasks compared with 8,114 flasks in 1932 and 356 flasks in 1931. AHE (15a)

The Non-Ferrous Foundry in 1933. A. J. MURPHY. *Foundry Trade Journal,* Vol. 50, Jan. 18, 1934, pages 53-54. Review of non-ferrous foundry practice in Great Britain during 1933. Melting practice, new high-tensile alloys, nickel alloys, and modified aluminum-silicon alloys are referred to in brief. OWE (15a)

The Non-Ferrous Metals in 1933. *Foundry Trade Journal,* Vol. 50, Jan. 18, 1934, pages 57-58. A discussion of the metal markets of the world during 1933. OWE (15a)

The Light Castings Industry in 1933. CAPT. KENNARD. *Foundry Trade Journal,* Vol. 50, Jan. 18, 1934, page 52. A review of the above industry in Great Britain during 1933. OWE (15a)

The Canning Industry. T. N. MORRIS. *Tin,* Mar. 1934, pages 17-19, Apr. 1934, pages 6-9. Historical and statistical data of the British canning industry are presented, the canning processes and metals used in the industry are described and some of the metallurgical problems still to be solved and economical aspects discussed. Ha (15a)

Historical (15b)

Lead—Probably the Oldest Type of Metal Roof. *Sheet Metal Worker,* Vol. 25, Jan. 1934, pages 19-20. Lead-roofing was used already in ancient Babylon, and the lead roof on the Pantheon in Rome is still in service after 1800 years. Many examples of more recent times are given. Sheet lead in olden times was cast in flat sand molds. Ha (15b)

A History of the Introduction of the MacArthur-Forrest Cyanide Process to the Witwatersrand Goldfields. JAS. GRAY & J. A. MCLACHLAN. *Journal Chemical, Metallurgical & Mining Society of South Africa,* Vol. 33, June 1933, pages 375-397; Vol. 34, Aug. 1933, pages 74-75. Historical. AHE (15b)

An Old Naval Foundry : Indret (Une Vieille Fonderie de la Marine : Indret) MOUTARD. *La Fonte,* Vol. 3, July-Aug.-Sept. 1933, pages 303-319. Second part of the story from 1827 up to 1933 of the old French naval foundry which has been replaced by a new one description of which is given. FR (15b)

Origin of the Oldest Iron and Steel (Die Herkunft des ältesten Eisens und Stahls) HEINRICH QUIRING. *Forschungen und Fortschritte,* Vol. 9, Mar. 20, 1934, pages 126-127. Historically reviews the findings on Fe and steel between 4000 and 800 B. C. and arrives at the conclusion that the first commercial production of wrought Fe from hematite and hardening in a charcoal fire had been accomplished in Armenia at about 1400 B. C. EF (15b)

Alloy Tool Steels and the Development of High Speed Steel. ARTHUR S. TOWNSEND. *Transactions American Society for Steel Treating,* Vol. 21, Sept. 1933, pages 769-795. Traces the history of alloy tool steels from 1868-1933 with an effort to establish facts regarding certain disputed points and give credit for contributions where due. It is attempted to determine precisely what Taylor and White invented. 71 references. WLC (15b)

Bells—Their History and Manufacture. E. DENISON TAYLOR. *Edgar Allen News,* Vol. 12, Apr. 1934, pages 423-425; May 1934, pages 434-436. A history and description of old bells is given, laws of ringing of bells and carillons described. Bells are cast of Cu-Sn alloy, steel bells have not been found satisfactory. Ha (15b)

One Hundred Years of Sheet Copper. *Sheet Metal Worker,* Vol. 25, Jan. 1934, pages 21-22. Historical sketch of the industry in U. S. A. Ha (15b)

Z-Z-Z-Z

. . . HAVE YOU HEARD *the one about the traveling salesman?*

He went to bed at the William Penn and slept twenty years! Well, maybe that is a little exaggerated. But anyway, the beds at Pittsburgh's number one hotel are so comfortable you don't ever want to get up. The food in the four famous restaurants is equally exceptional, and the prices reasonable. Quiet, well-furnished rooms, $3.50 single; $5.00 double, all with bath.

1600 ROOMS . 1600 BATHS

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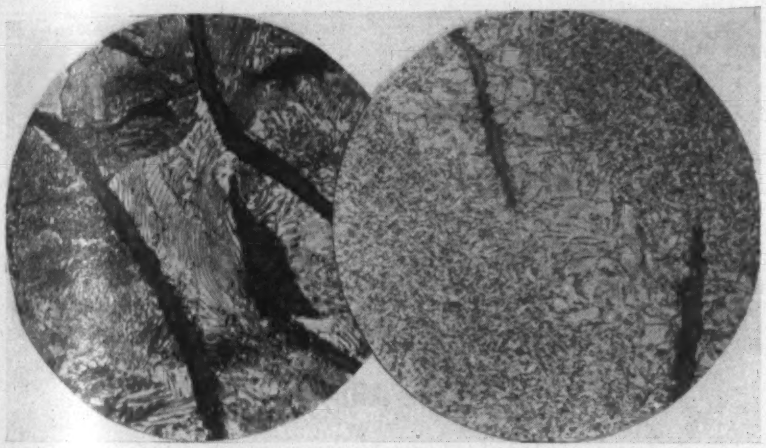
NEW EQUIPMENT AND MATERIALS

Cecolloy

Chambersburg Engineering Company, Chambersburg, Pa., has developed a series of synthetic nickel-molybdenum air-furnace iron alloys, which they have grouped under the trade name of Cecolloy. The development of Cecolloy came through the metallurgical research undertaken by Chambersburg engineers during the depression, in the desire to increase the production capacity, increase the accuracy and reduce the maintenance cost of the forging hammer. This research pointed to an ideal metal for anvils and frames, combining the mass and vibration-resisting properties of gray iron with the strength and wear-resisting properties of steel, yet free from the deficiencies of both these metals.


Ordinary Cast Iron   Cecolloy

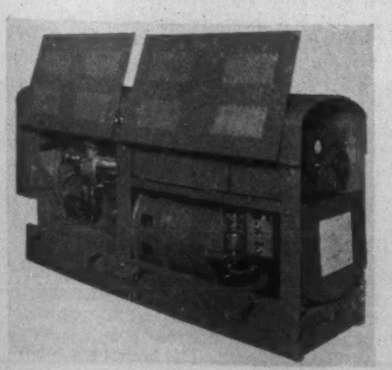
The chief characteristics of Cecolloy are a fine homogeneous grain structure, a tensile strength of from 40,000 to 60,000 lbs./in.², and a Brinell hardness which can be controlled in the furnace to suit the purpose for which the casting is intended. Carbon content can also be controlled within ±.05%.

Up to the present, a casting of 7 or 8 tons was fairly large for alloys of this type. The success of Cecolloy in castings weighing up to 50 tons is the result of the careful study and experiment made by the foundry division of Chambersburg Engineering Company, which has specialized in heavy castings for almost half a century.

Chambersburg's foundry division is not only making castings of Cecolloy for their own hammers and presses, but is also making castings of this alloy for other industries. Cecolloy is recommended highly for such castings as forming dies, beds for heavy duty machine tools, steam cylinder liners and rings, hydraulically operated gates and valves of large size, crushing machinery, rabbling equipment, feed-hoppers, and chemical vessels where the impermeability of the metal is of vital importance.

New Gas Engine Driven Welder

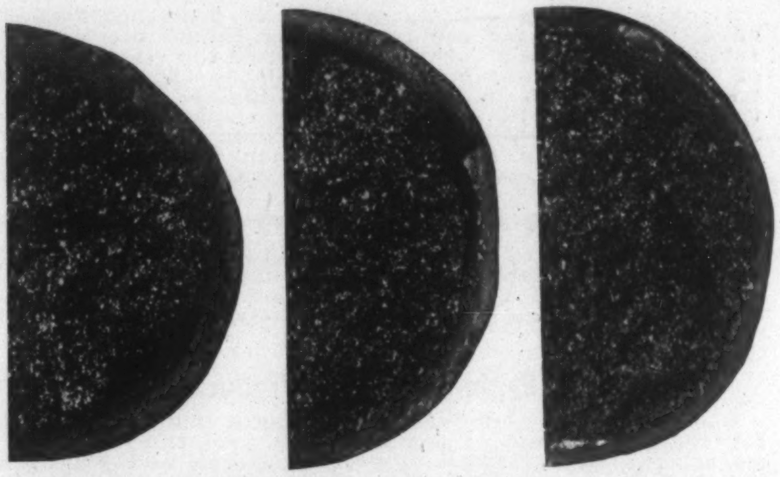
A new close coupled gas engine driven "Shield-Arc" welder of 300 ampere, 40 volt capacity is announced by The Lincoln Electric Company, Cleveland, Ohio. Due to the close coupling feature, the new unit is much more compact and of lighter weight than previous models. The generator is mounted on the engine housing with the drive lined up on hardened steel and driven on cushioned rubber. This method of coupling takes care of any misalignment and reduces vibration. A special idling device which cuts the engine speed when the arc is broken further assures of economical operation of the six cylinder engine. The welder is supplied mounted on a rigid steel base with totally enclosed steel side curtains. Where desired the complete unit is mounted on small factory portable steel wheels, or large 6" face steel wheels for outside use or on 2 or 4 wheel pneumatic tired trailers.



A uniform generator current permits use of a higher average current with greatly increased welding speed. The capacity of the new welding machine is 60% higher than its predecessor and it is rated at 40 volts. According to the manufacturer, the "Shield Arc" welder has 10% higher efficiency at full loads and still more on overloads, even though it is of much greater capacity. Other features of the "Shield Arc" welder include dual control of welding heat, sparkless commutation, handy-height controls, and arc welded steel construction. Lincontrol, a new remote current control device which enables the operator to adjust the current by merely tapping the electrode on the work is supplied as optional equipment. No additional cables or rheostat are carried by the operator. By quickly adjusting the current without making a trip back to the machine, much waste time is entirely eliminated.

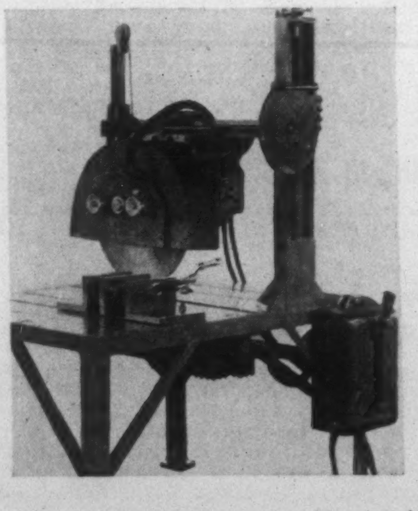
New Liquid Carburizer

E. F. Houghton & Company, Philadelphia, has just announced a new carburizer for small work—"PERLITON Liquid Carburizer." Work on this process began in that company's German plant two years ago, where it was developed and tested by the largest metal working concerns in Germany who gave it their approval. It was then tested in large automotive plants in this country with results which the manufacturers state will "revolutionize the science of carburizing small parts." It has given twice to three times the penetration in a given time as compared to other methods now in use—a factor most important in the speed of modern production. A pot life of up to 1200 hrs. was also shown by Perliton, which compares to an average from 300 to 500 hrs. for other liquid salt bath mediums. The advantages claimed for Perliton include: Uniformity in depth of case and carbon content; low cost per ton of steel; longer pot life; no decarburization; non-hygroscopic; high thermo-conductivity; lower consumption than other salt mediums; no variation in degree of fluidity; reduced heating time; no rust after water quenching. In a statement issued by the manufacturer it is pointed out that "in the past it has been difficult to control the depth of case and carbon content on small parts when carburized on a production basis using large carburizing boxes. Parts packed close to the sides of the boxes showed greater carburized depth and higher content than those packed in the center. The time required to pack and unpack boxes, heat them to proper temperatures, etc., was an obstacle to rapid heat treatment and an added expense."


S. A. E. 1020 Steel Carburized at 1650°-1675° F. for 120, 80 and 40 Minutes, Left to Right, Respectfully. Magnification 6X.

Electric-Arc Saw

The Rich Manufacturing Co., Los Angeles, Calif., announce a metal cutting saw, employing an arc to bring the metal to be cut to a plastic or molten condition. Pressure created by the high speed of the saw blows the molten metal from the scarf. The saw is of circular form, of comparatively soft steel and carries a multitude of small straight teeth on its circumference. In operation it is rotated at a high speed and fed into the work. The arc which is formed between the teeth of the saw and the material to be cut is concentrated on the material to be cut directly in front of the teeth. As the speed of travel through the material to be cut is high, the arc is only concentrated at any point for a short period of time. Therefore, there results only a very shallow overheated area at the sides of the scarf, not over one millimeter in depth. This is negligible in comparison to that found in cutting with the oxy-acetylene torch or with a friction saw. The width of the cut is slightly greater than the width of the saw, being in the case of a ¼" thick saw, approximately 9/32". The cut itself is as smooth, if not smoother, than that made by a cold saw. Cuts have been made on spring steels, manganese steels, hard facing alloys, tungsten and tantalum carbides without trouble or injury to the blade. Tempered steels can be cut without affecting their temper. As the arc does the work, hardness of materials has no effect.



The cutting current is delivered by an 800 ampere d.c. motor generator set having a separate exciter. The cutting speed of the saw must be regulated, depending on the cross section to be cut or machined. To secure the most accurate speed regulation, a d.c. motor where current is taken from the separate exciter of the motor generator set, is provided. This motor will drive the carriage to which the material to be machined is mounted upon. The motor generator set can be used for either hand or automatic arc-welding purposes when not in use for arc-cutting.

MANUFACTURERS' LITERATURE

Note: (This department is conducted for the convenience of the readers of METALS & ALLOYS *desiring to add to their files copies of current literature issued by manufacturers. Any items desired can be secured free by applying direct to the issuing firms or in those cases where a number of items are wanted applications may be sent direct to this office. A coupon is provided on which the numbers of the items required can be listed.)*

Sizes We Roll

Booklet, fourth edition, which has been prepared as a handy reference for use in ordering Inland Steel products. Includes in compact form lists of all of the sizes and shapes of the various products rolled with the exception of rails, track accessories and tin mill products (information on these products will be furnished on request). Many useful data are also available in the various tables which have been incorporated in this publication. Inland Steel Company, 38 South Dearborn Street, Chicago, Ill. (359)

Tantalum—The Answer to Severe Corrosion Problems

Booklet, the text of which relates to the uses of Tantalum as a corrosion resistant. Illustrations. Tables of technical characteristics of certain metals, corrosion resistance, and tests of Tantalum. Fansteel Products Co., North Chicago, Ill. (360)

Eagle Insulation Products

Booklet giving complete list of Eagle Insulation Products for complete range of temperatures. Contains data on fill materials, flat materials, pipe insulations and plastic materials. The Eagle-Picher Lead Co., Cincinnati, Ohio. (361)

Brass Die Castings with Strength of Steel

Booklet containing data on Doehler BRASTIL, a copper base alloy containing more than 81% copper and distinguished from ordinary copper alloys by high strength and hardness, high resistance to fatigue, shock and corrosion—good bearing qualities and beautiful pale gold color. Also Doehler MANGANESE BRONZE ALLOY, which meets the requirements of S.A.E. specification No. 43, and A.S.T.M. specification B-54-27 for cast brass with essential chemical constituents of copper, zinc, tin and aluminum. Also Doehler WHITE NICKEL BRASS, a copper base alloy containing copper, zinc, nickel and manganese, similar in color and properties to the nickel silver type of alloys. Physical properties of these alloys are set forth. Illustrated profusely. Doehler Die Casting Co., 386 Fourth Avenue, New York, N. Y. (362)

Turned and Ground Shafting

Leaflet setting forth data on Union Precision Shafting which is claimed to give machinery greater efficiency and longer life. Union Drawn Steel Co., Massillon, Ohio (363).

Published by the same firm: "Better Parts Production with Union Free Cut," leaflet containing information Union Free Cut, Bessemer screw steel and Union Supercut (high sulphur screw steel) for "automatic" production.

The Harshaw Chemical Company . . . A Presentation

A history of this company is set forth in an attractive booklet. The Harshaw Chemical Co., Cleveland, Ohio. (364)

Published by the same firm: "Harshaw Chemicals for the Metal Industries," "Uses and Suggestion for Use of Cobalt, Lead and Manganese Soluble Driers," "Harshaw Universal Driers," "Harshaw Commodity Laundry Sours," "Harshaw Industrial Chemicals."

Lincoln "Shield Arc" Welder

General specifications for A.C. motor driven types SA300, SA400, SA600. The Lincoln Electric Co., Cleveland, Ohio. (365)

"101 Uses for the Air Acetylene Flame"

New 8 page illustrated booklet describing the outfit necessary for the work and discusses the advantages of the process. Takes up in succession a number of different fields where the process is extremely useful. These include plumbing and piping, air conditioning and refrigeration, marine work, automotive repair, power and electrical and others. All repair men whose work includes soldering, brazing or heating operations will want a copy of this new booklet. The Linde Air Products Company, 30 East 42nd Street, New York, N. Y. (366)

Manual for Heat Treating Steels with Cyanides and Salts

Just off the press, a handy and highly informative manual for the metallurgist and steel treater. Covers the procedure to be followed for case hardening, reheating, nitriding and mottling steels with du Pont sodium cyanide. It also describes the procedure for coloring, tempering and drawing steels with du Pont heat treating salts. Typical of the scope of the manual is the section devoted to the discussion of the influence of time of immersion, temperature, composition of the bath and the type of steel on the composition and depth of the case obtained with cyanide. Microphotographs show the effects of temperature on the composition of the case. Methods of analysis of mixtures, heat treating tables and other data add to the value of the manual as a contribution to the art of heat treating steels. 28 pages, bound in a sturdy paper cover. E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware. (367)

The Maintenance of Reciprocating Parts

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